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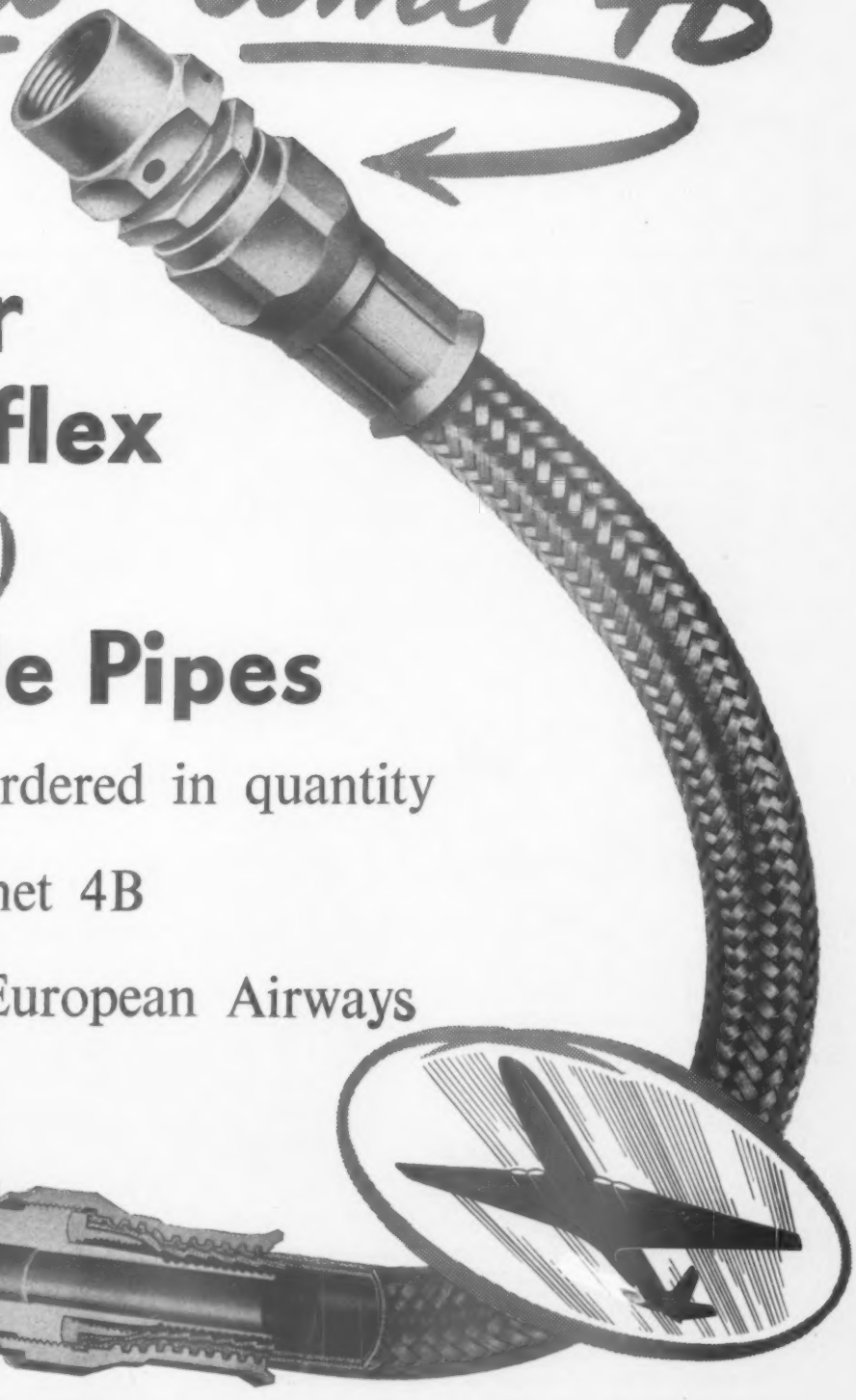

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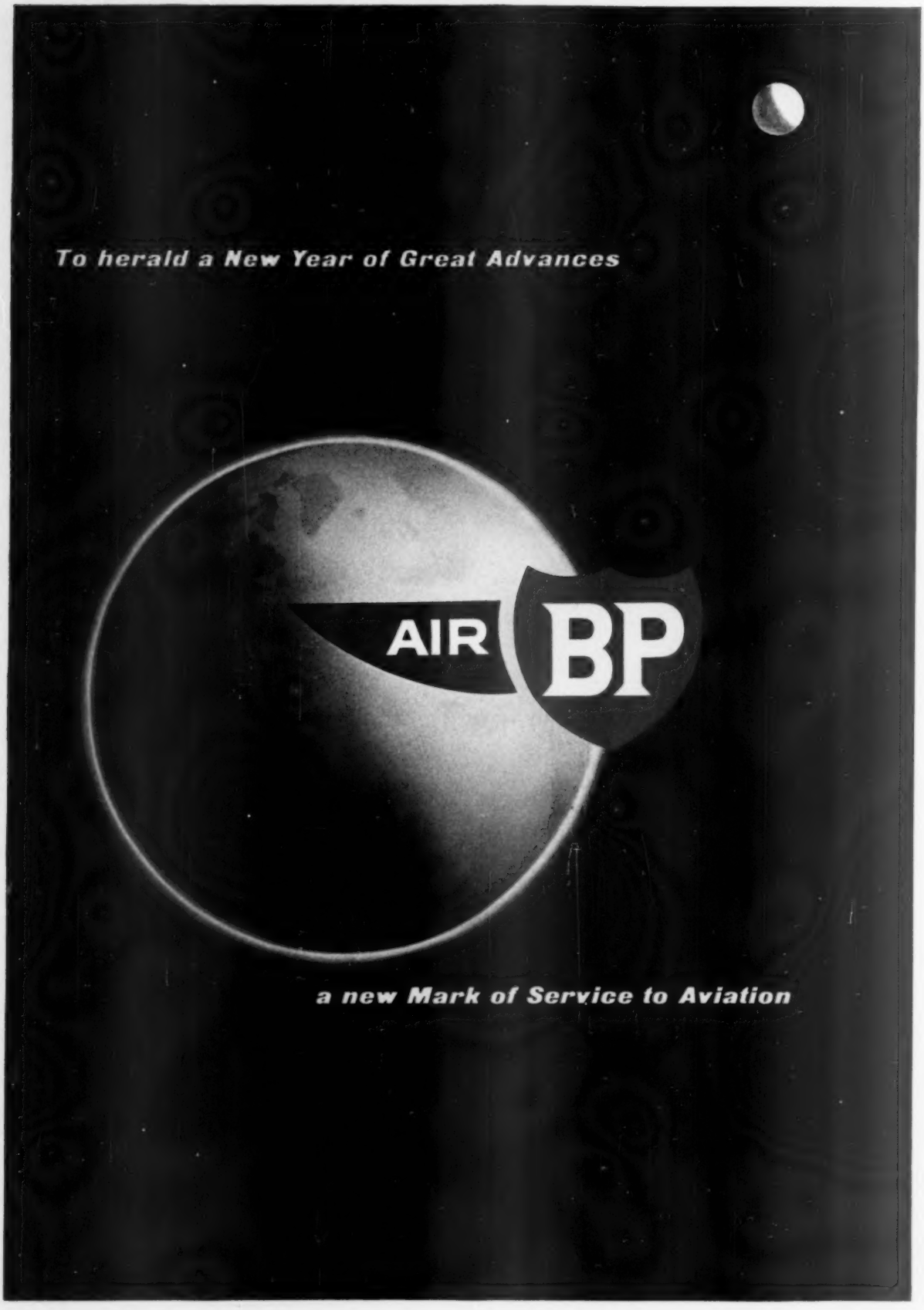
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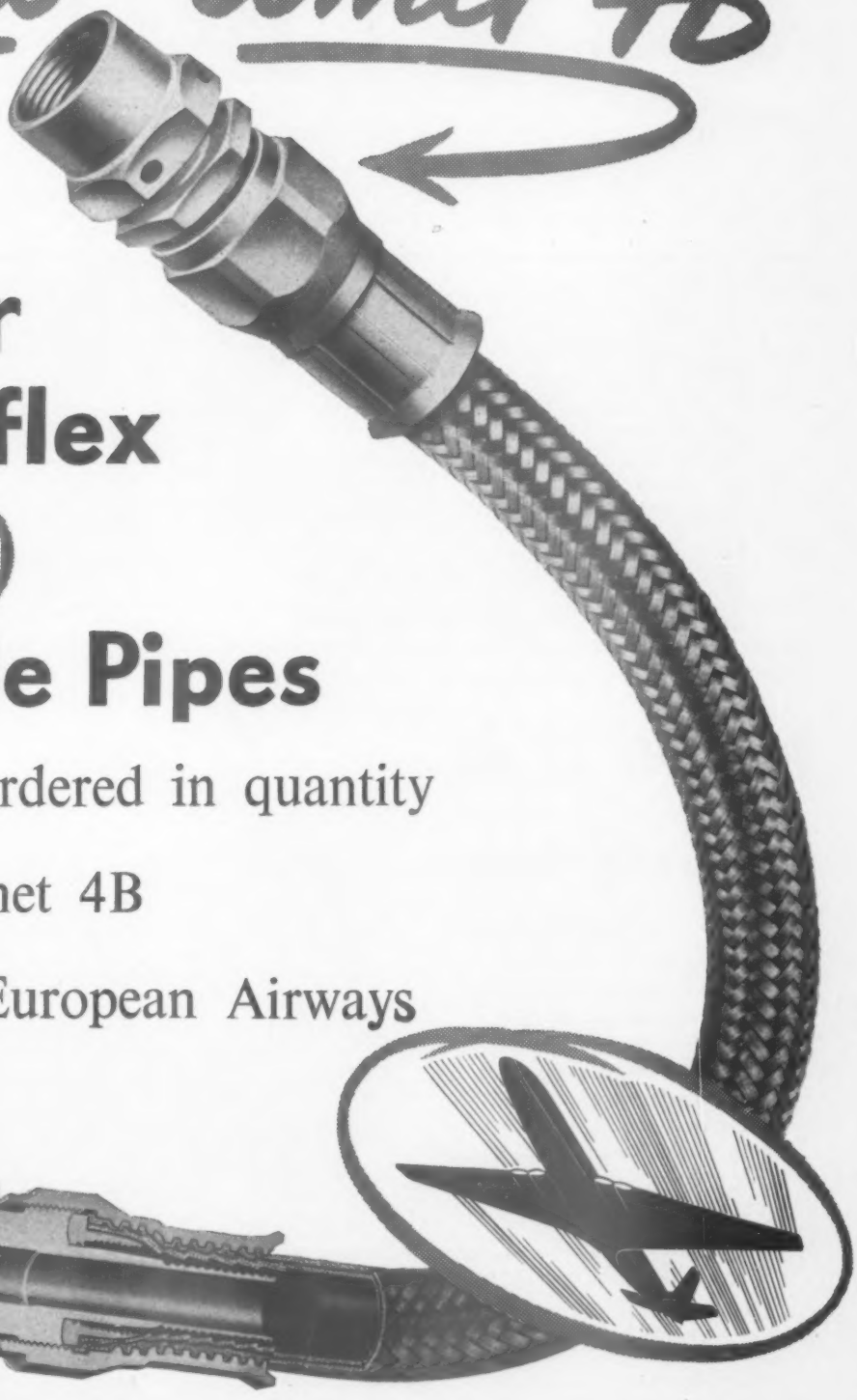

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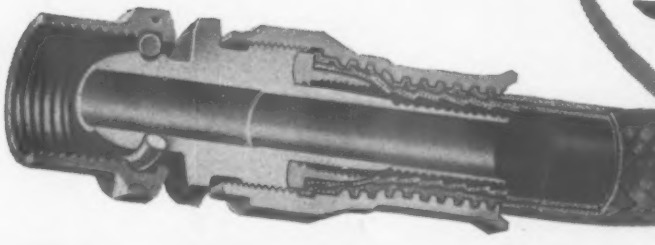

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P.1534

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CIBA (A.R.L.) Limited have published in book form all the information made available during the Conference at Cambridge on Bonded Aircraft Structures. The sixteen papers read by the world's leading technologists on this subject are printed in full, together with a foreword by Sir William Farren, Technical Director, A. V. Roe & Co. Ltd; and formerly Director of the R.A.E., Farnborough. The book, which has more than 180 pages, contains all the drawings and photographs used by the lecturers, making it the most comprehensive work of its type available.

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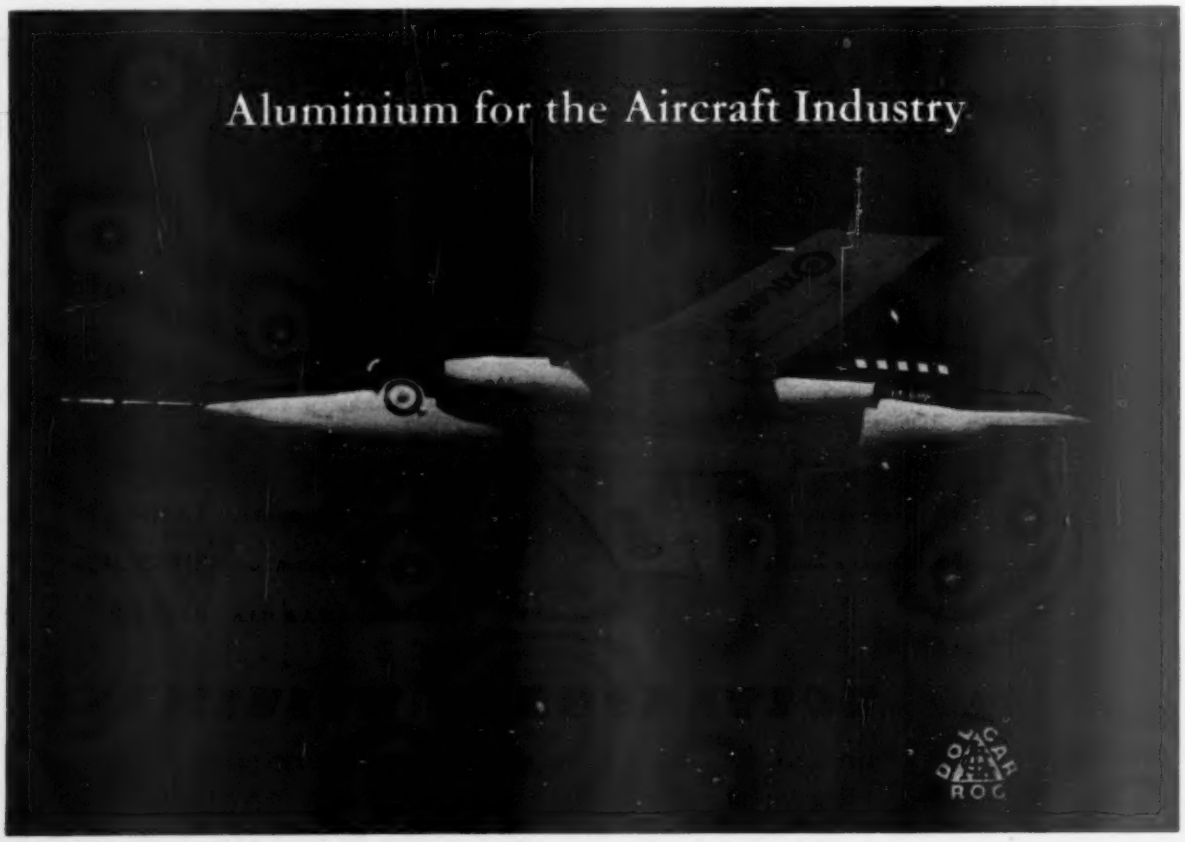

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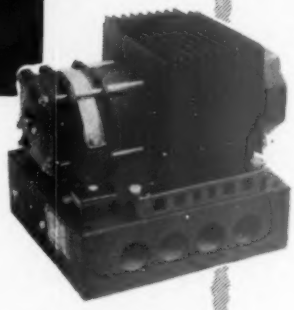

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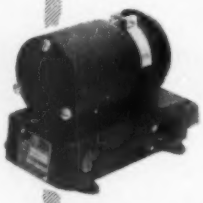

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THE AEROPLANE

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Aeronautical Engineering
Edited by - - THURSTAN JAMES

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SPACE EXPLORATION—THE NEXT STEP

THERE can be no doubt that the news of last week was the statement by Sir Thomas Sopwith that the time had come for the Government to show their firm determination to enter the space age. The lack of such determination has been obvious for long enough. And readers of THE AEROPLANE know for what a long time we have been at this particular problem trying to get some national effort into orbit. Now that the chairman of an industrial complex, as large as the Hawker Siddeley Group, has made the headlines with his call to enter the Space Age we can expect to see a building-up of public interest and, in consequence, political acceptance of the need to get a plan worked out.

The newspapers can be expected to carry more and more news about space flight activities as the summer wears on and the time approaches when the British Interplanetary Society is organizing two conferences in swift succession. But in parallel with the build-up of public interest effective co-ordination at the scientific level is needed. The subject is much too vast to be left to the consideration of various defence committees.

Even in the United States, where to our way of thinking so much more progress has been made, there is still a great deal of dissatisfaction with the way things are working out. A critical article in the current issue of *Time* has an informative chart which shows that at the highest level in that country is the National Aeronautics and Space Council of which the President himself is chairman. Below this is the recently constituted National Aeronautics and Space Administration which oversees civilian projects and on the same level is the Advanced Research Projects Agency (ARPA) of the Department of Defence which looks after military projects. Below ARPA come the three Service Departments with their Missile Commands and Divisions. And even this organization does not work, it seems, as well as it should.

In this country the subject is never discussed publicly by Government Departments and in consequence the people of this country have no idea who is giving advice on space problems nor do they know who is taking the responsibility for not having anything done about it.

We do not propose to argue whether exploration of space is worth while or not. Both the Russians, who have shot a rocket far beyond the Moon, and the Americans, who have successfully put five satellites in orbit, think it is. Young scientists and engineers everywhere are fascinated by the problems involved. Various learned bodies have staged conferences and symposia to discuss some of the problems involved. But so far no senior Minister has expressed British Government policy concerning this matter.

In passing it seems reasonable to express the view that excessive security measures intended to preserve the military capabilities of our anti-aircraft rockets have played no small part in keeping the public ignorant of the qualities and achievements of the engineering teams which have been built up by the British aircraft and electronic industries. Every now and then the curtain lifts so that we learn, as we did last week, for instance, of the remarkable performance on test with the Navy of the de Havilland Firestreak. Something has been said too about the Bristol Bloodhound now being supplied to the R.A.F. for operational use.

We already have high-level authority for the statement that the work being done with the Black Knight re-entry test vehicle and with Blue Streak, that is the de Havilland/Rolls-Royce Long Range Ballistic Missile, could serve as a foundation from which to develop space vehicles. But this is not the only form of attack and studies done by A. V. Roe and Co., Ltd., show that a more conventional aircraft might well be used for experimental satellite work.

However, before anything can be put in hand the Government must say whether or not it intends that this country shall take part in the exploration of space. Once this has been said, and surely only one answer is possible, the next step is to set up a Board to co-ordinate Space Exploration. Bearing in mind the very remarkable contributions made to aeronautical development by the countries of the Commonwealth, this B.C.S.E. would only develop its full potentialities if scientists from the Commonwealth were included in its membership. Mr. Crawford Gordon, following the Hawker Siddeley meeting, suggested a Commonwealth Outer Space Agency.

This Board will have to advise, among other things, whether the Commonwealth should have its own programme, whether it should invite the co-operation of our friends in Europe or whether it should offer to help the American programme. These decisions have got to be made and in view of the large slice of the national income that will be needed to implement them, public opinion has got to be studied and convinced at each step. It is not to be expected that the next stage of man's journey to the stars is going to be any less arduous than have the first stages devoted to building successful flying machines.

Matters of Moment

Ministerial Appointments

AS a result of Commander Noble's resignation certain changes—announced on January 16—have been made in the appointments of junior Ministers and three affect British aviation.

Mr. Charles I. Orr-Ewing, who has been Parliamentary Under-Secretary, Air Ministry, since 1957, becomes Parliamentary and Financial Secretary at the Admiralty; Mr. Airey Neave, formerly Joint Parliamentary Secretary, M.T.C.A., becomes Parliamentary Under-Secretary at the Air Ministry, and Mr. John A. Hay takes over the post vacated by Mr. Neave.

Mr. Hay has been M.P. for Henley since 1950. Now aged 39, he served in the R.N.V.R. during the Second World War. From 1951 to 1956 he was Parliamentary Private Secretary, Board of Trade. (Portraits are on page 88.)

Hawker Siddeley's Year

A PLEA for a British programme of space research was a feature of the speech by Sir Thomas Sopwith, chairman of the Hawker Siddeley Group, at the Group's annual general meeting in London on January 15. In his view "it will be a tragedy if the Government does not give a clear lead and show its firm determination to enter the Space Age without further delay. I know this will cost money, much money, but our position in the World, politically and economically, depends on leadership, and we cannot be among the leaders unless British satellites are in orbit and British space ships are being planned."

Sir Thomas' statement is most timely. A note in THE AEROPLANE of November 28, 1958, described the manned-satellite studies on which an Armstrong Whitworth design team has been working for more than 18 months under Dr. W. F. Hilton, the company's chief aerodynamicist. Also involved in Hawker Siddeley space studies are Mr. E. P. Hawthorne, chief executive of the Hawker Siddeley Nuclear Power Company, and Mr. J. E. Allen, head of the aerodynamics, projects and assessment dept. of the Avro Weapons Research Division.

On January 7 Sir Arnold Hall, technical director of the Group and responsible for its space studies, stated that Britain should launch a space programme and that either ballistic missiles or air-launched vehicles could be used.

In his speech Sir Thomas gave figures which showed the present size of the Hawker Siddeley Group. It has some 100,000 employees, of which there are about 60,000 in Britain and 40,000 in Canada. Its total assets exceed £200 million. Its exports in the year ended July 31, 1958, were approximately £48 million—£27 million from the United Kingdom and £21 million from Canada. The Group's net profit for the year was £5,118,601. Sir Thomas also revealed that the company was planning to issue £15 million of convertible debentures.

The interests of the Group are divided between its Industrial and Aviation Divisions. In surveying the work of the Aviation Division, which accounts for only about 30% of the Group's assets, Sir Thomas said that it had provided the R.A.F. with the Hawker Hunter, Gloster Javelin, Avro Vulcan and Avro Shackleton. The Armstrong Whitworth Sea Hawk was in front-line service with the Fleet Air Arm and the Avro Canada CF-100 was helping NATO defence. Vulcans, Hunters, Shackletons and Javelins were still in production; the order book, both home and export, was substantial.

Group interests in the missile field included the Armstrong Whitworth Seaslug for the Royal Navy and the Armstrong Siddeley rocket motor which powered the Black Knight. The Avro stand-off bomb was being developed for V-bombers.

The Hawker Siddeley board felt that manned military aircraft would be required for years to come and there was top-level military support for this view in Europe and North America.

In Canada the Arrow supersonic fighter had exceeded expectations in performance and there was hope that this would lead to further production orders. Development of the Canadian Iroquois engine was going very well.

In Britain the Armstrong Whitworth Argosy turboprop freighter had begun its flight trials. Its development had been financed by the Group as a private venture and it was hoped that a firm production order for it would be received from the Ministry of Supply. The aircraft would be operated by R.A.F. Transport Command.

REPORTING PROGRESS.—Sir Thomas Sopwith presents the chairman's report at the Hawker Siddeley Group annual general meeting on January 15. On Sir Thomas' right is Sir Roy Dobson, the group's managing director.

There were a number of new projects in the design and development stage; these included "a novel form of vertical-take-off close-support fighter from Hawkers" and the Avro 748 transport, whose first flight would be next year.

Hawker Siddeley had gone further than anyone else in meeting the Government's wishes for the development of stronger units within the industry. Not only had it merged its interests into a single new Division of immense strength, but on the engine side the decision had been taken to merge Bristol Aero-Engines and Armstrong Siddeley Motors into a single operating company. An encouraging factor in this logical amalgamation was that the Bristol-Siddeley Olympus engine had been chosen for the new tactical support and reconnaissance aircraft for the R.A.F., the TSR-2.

British Instrumentation Link-up

LAST week a joint statement was issued by Smiths Aircraft Instruments, Ltd., and Kelvin and Hughes, Ltd., in conjunction with the Sperry Gyroscope Co., Ltd. (Brentford Division), announcing an arrangement between the two groups for collaboration in certain major projects for aircraft control and instrumentation systems covering all aspects of such enterprises. There is no financial tie-up involved, but the aviation activities of both organizations will be directed by an executive panel at director level.

The collaboration is completely confined to aircraft work and it is too early at this stage to predict what effect it will have

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TWO PRESENTATIONS.—Left, Mr. H. M. Woodhams, managing director of Armstrong Whitworth Aircraft receives from Mr. W. D. Lockwood, (on the left) a presentation book to commemorate 50 active years in aviation. Right, Sir Arnold Hall, president of the Royal Aeronautical Society presents an Honorary Companionship of the Society to the aero-engine pioneer Mr. Gustavus Green (see page 105).

on the general sales policies of both groups. As already stated, the arrangement is at present limited to specific aeronautical projects, the first of which will be the development of a flight control and instrumentation system for the de Havilland 121 transport for B.E.A. No technical details on the D.H.121 flight system are available at the moment.

Engineers and technical facilities of both groups are being employed in this work. The three companies are also much interested in other civil and military aircraft, such as the TSR-2 tactical support and reconnaissance aircraft for the R.A.F.

A Second London Heliport?

ROTORPORTS, LTD., has applied for a lease on a site at Nine Elms on the south bank of the Thames and is proposing to build a heliport there. A public inquiry into the proposal will be held by the Ministry of Housing and Local Government. Its provisional date is February 25.

The river frontage of the Rotorports site is 300 ft. long. It is proposed initially to build a 150 ft. × 125 ft. landing platform out over the river. The company estimates that it will handle about 10 helicopter movements a week at the start, rising to 30-40 movements per week within a year. It is hoped that the heliport will be used by B.E.A., Sabena and charter operators.

Rotorports, Ltd., also has plans for a subsidiary company to operate helicopter services and has applied to the Air Transport Advisory Council for permission to run scheduled services, initially with S-58s, Vertol 44s and Bell 47Js and later with Westminsters and Rotodynes. One application has been made "for the carriage of passengers, supplementary freight and mail on the route London Airport-London (York Road) and/or London (Nine Elms) and/or Southend and/or Manston and/or Rochester at an initial frequency of five return flights daily increasing in accordance with traffic demand for 10 years from July 1, 1959."

Three other applications for scheduled services with the same frequency have been made by Rotorports, Ltd. They are on the routes London (Hendon)-London (Nine Elms) and/or London (York Road)-London (Gatwick); Southampton (Eastleigh)-Cowes-Ryde-Portsmouth-London (Nine Elms) and/or London (York Road); London (Nine Elms) and/or London (York Road)-Birmingham-Manchester. Although these applications are in the name of Rotoports, Ltd., they would actually be operated by a subsidiary company.

If Rotorports receives planning permission to build its heliport at Nine Elms, London will have two heliports on the south bank of the Thames within three miles of each other. Westland Aircraft, Ltd., was given planning consent in July last year to build a heliport on the south bank of the Thames between Battersea Railway Bridge and Wandsworth Bridge. Construction of this heliport is now well advanced. The Westland heliport will be operated for seven years, but the Rotorports scheme aims at providing a permanent heliport for London.

The ultimate future of these heliports obviously depends on their use for scheduled services; they would come into their own if trans-Channel helicopter services were to be run by an operator such as Sabena.

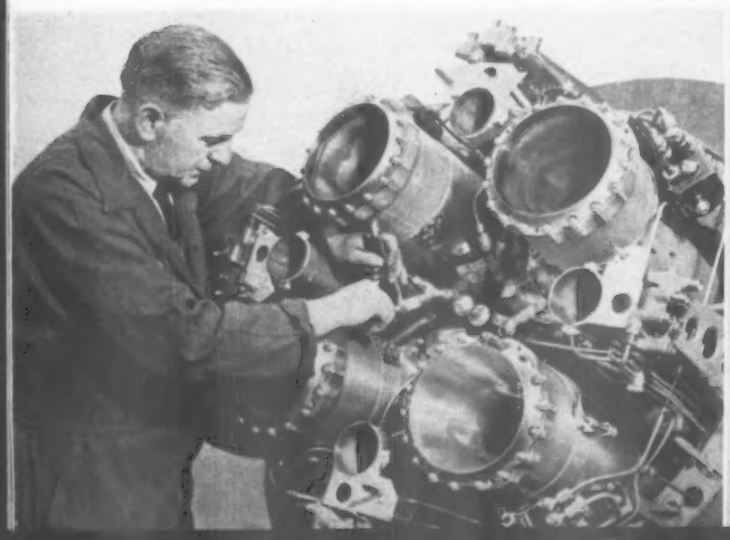
Black Knight Engine

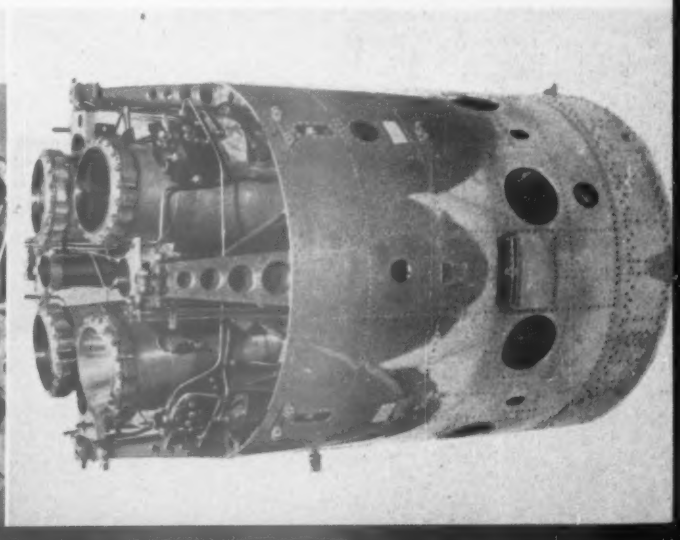
POWERPLANT of the successful Saunders-Roe Black Knight re-entry test vehicle, the Armstrong Siddeley Gamma Mk. 201 rocket engine, is essentially a four-barrel development of the original Gamma rocket. The early engine was developed by the then R.A.E. Rocket Propulsion Department, now known as the Rocket Propulsion Establishment, at Westcott.

When development of the Black Knight was started by the R.A.E., design of the powerplant was based on four Gamma units. Retaining overall authority for the design, the R.A.E. made Saunders-Roe the main contractor for the complete vehicle and that company placed a contract with Armstrong Siddeley for the engine.

The Gamma Mk. 201 for the Black Knight has a thrust of 16,400 lb. at sea-level, increasing to nearly 19,000 lb. outside the Earth's atmosphere. The four combustion chamber barrels

BLACK KNIGHT'S POWERPLANT.—Two new photographs just released show details of the Armstrong Siddeley Gamma rocket engine for the Black Knight re-entry test vehicle. Gamma uses hydrogen peroxide and kerosene and gives 16,400 lb. at sea level.





MEN IN THE NEWS.—New Ministerial posts are announced on page 86. Left to right, Mr. Airey Neave, D.S.O., O.B.E., M.C., T.D., M.P.; Mr. C. I. Orr-Ewing, O.B.E., M.P., and Mr. J. A. Hay, M.P.

are equally disposed around the body axis of the vehicle. They are mounted on trunnions so that they can be rotated about axes radiating from this axis of the vehicle.

Each barrel has a hydraulic actuator to control angular movement, as decreed by the guidance system. As it is not intended that the Black Knight should roll during flight, two diametrically opposite barrels are rotated together to control the vehicle in the pitching axis and the other pair to control yaw. Any tendency to roll is counteracted by all four barrels being rotated in the appropriate direction.

The combustion-chamber mounting trunnions are hollow to provide supply lines for oxidant and fuel. High-test peroxide (HTP) is pumped through each inboard trunnion to the outer shells of a combustion chamber and passes between the two shells of the chamber to cool the inner shell (which would otherwise reach about 2,770° K.) before entering a catalyst pack of silver-plated nickel gauze at the top of the chamber.

Kerosene fuel enters each chamber through its outboard trunnion and, on starting up, is supplied as soon as there is a pressure rise indicating enough decomposition of the HTP into superheated steam and oxygen. Immediately before admission of fuel, the fuel line is purged by nitrogen from a launching pad supply to prevent reaction of HTP to kerosene. On admission to the chamber at the correct time, thermal ignition takes places immediately.

Each of the four combustion chambers is supplied with propellents by its own turbopump, the four units joining a common HTP manifold to form a rigid cruciform fixed to the vehicle structure at each of the fuel-pump suction "elbows." Centrifugal impellers of the HTP and fuel pumps are mounted at opposite ends of the shaft carrying the turbine rotor.

A separate catalyst pack decomposes HTP and the products of this decomposition impinge on the axial-flow turbine to drive the propellent pumps. For starting, HTP is supplied under pressure from a ground source which, like the nitrogen purging supply, is automatically cut-off as the vehicle rises from the launching pad. At this stage the HTP pump-pressure has risen high enough for HTP to be supplied to the turbine through a control valve.

Hydraulic pumps are driven by two of the turbopumps through kerosene-lubricated reduction gears. The engine bay of the vehicle contains a hydraulic reservoir and accumulator. Weight of the complete engine section of the Black Knight is about 700 lb.

Type-test clearance of Gamma Mk. 201 was over a year ago and Saunders-Roe have since taken delivery of several engines. After testing and calibration by Armstrong Siddeley each engine is dried-out and delivered to Saunders-Roe, who give it a further short run when the vehicle is complete. The engine is again dried-out and flown to Australia. So far, no engine has failed to start and run as required. One hopes soon to hear of a second and subsequent successful firings of the Black Knight.

Bendix Flight Control

WE understand that the Bendix PB-20 automatic flight control system, to be manufactured in this country by the Aviation Division of Elliott Brothers (London), Ltd., is to be installed in the Vickers V.C.10 fleet ordered by B.O.A.C. This is the first occasion that B.O.A.C. has selected an American flight system for use in a British aircraft, but the Corporation has operated a number of American transports since 1945 and its 15 Boeing 707s will have the PB-20 equipment. This Bendix system is approved and already in service in a number of large jet aircraft.

Next month the Bendix Aviation Corporation is planning an exhibition in Paris as part of a series of demonstrations of its aircraft and missile equipment. These have been requested by a number of European governments. Engineers from the corporation's radio, radar, electrical, autopilot, flight and engine instrument, and other divisions will demonstrate all types of ancillary equipment. Following the demonstrations, Bendix engineers are to visit the British guided missile industry at the invitation of the Ministry of Supply.

The Perils of Sabotage

ON January 15 in Nicosia Flt. Lt. R. G. B. Burr was sentenced to loss of a year's seniority and to a severe reprimand. He had been found guilty of negligence in performing his duties on October 29. This was the day on which a time bomb exploded close to a Comet aircraft in which 40 servicemen were about to return to England. In cross-examination Flt. Lt. Burr said that the baggage in which the bomb had been placed was his own.

Serious though the results of the incident were, a number of men being injured, the outcome could have been catastrophic. Suppose the bomb had gone off, as seems likely to have been planned, after the aircraft had left the ground, one could only expect the results to have been disastrous. There would have been a terrible death roll and all the misery and unhappiness that that would have caused. But frightful though this would have been in itself, the results might not have stopped there.

Suppose the explosion had occurred when the Comet was at its cruising height. This could have meant that the aircraft might have broken up at 30,000 ft. somewhere in the area in which the accident to B.O.A.C. Comets out of Rome occurred on January 10 and April 8, 1954. If disaster had happened at such a height and over the sea there might have been no eyewitnesses.

We should have needed an investigation on the lines of that which preceded the Comet inquiry to establish that the trouble was indeed caused by an internal explosion. And with no witnesses the wreckage might never have been found. Furthermore, there can be no certainty that the vital pieces of wreckage would ever have been traced.

All this is supposition, but the troubles in unhappy Cyprus, alas, are not yet over, and there is no knowing that there may not be further attempts to sabotage the Comets of R.A.F. Transport Command. It is dreadful to think that all their fine record of trouble-free service could be rendered nugatory by the successful planting of a terrorist's bomb.

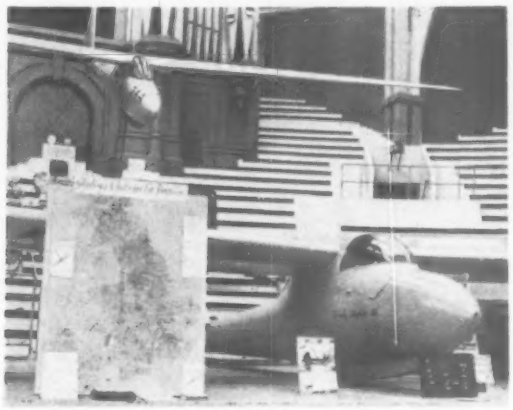
K.L.M. and Singapore

ALTHOUGH the reasons may be well understood in the limited field of air transport competition, the Government's decision to cut K.L.M.'s services to and from Singapore to a once-weekly frequency in support of B.O.A.C.'s complaints has caused a natural raising of eyebrows. Apart from ethical considerations, an eventual *quid pro quo* may well cause B.O.A.C. greater discomfort on some future occasion when it is K.L.M.'s turn to be tough.

K.L.M. has had terminal traffic rights at Singapore since December, 1957, when the Dutch were turned out of Indonesia and nationals had to be flown home. At first a five-a-week frequency was permitted; last March this was reduced to three a week. Naturally B.O.A.C. and Qantas have complained that they are now losing normal traffic to K.L.M.; the frequency was reduced to two at the end of June and is now, unless there is a change in policy following the criticisms in the Netherlands and even in this country, to be reduced to one a week—which is a barely worthwhile operation.

It remains to be seen, at the time of going to press, whether the Singapore Government will agree to this decision by the U.K. and whether K.L.M. will turn to Kuala Lumpur, Malaya, as an alternative terminal.

General Aviation News



ON SHOW.—The British Gliding Association has a stand at the Camping and Outdoor Life Exhibition at the Alexandra Palace. On it are a Slingsby Skylark 3B (front) and a standard EoN Olympia. The Exhibition closes on January 24.

Photograph copyright "The Aeroplane"

BELL VTOL FIGHTER.—An artist's conception of a proposed Mach-2 Bell VTOL fighter, the D-188A, shows two pivoting G.E. J85 2,000-lb. thrust turbojets at each wing tip, two exhausting below the centre fuselage and two more at the tail. The efflux from all eight can be rotated through a right-angle for transition.

This year special functions are to be held, including a rally for amateur-built aeroplanes, probably in August, and a model contest between all the Nordic countries. Chairman of the club is Mr. Hjalmar Ibsen; vice-chairman is Mr. Einar Dessau, who has been a member since 1909. Mr. John Foltmann is the secretary-general.

INSURANCE MOVE.—The Aviation and General Insurance Co., Ltd., has moved its registered office to 5th floor, Royal Mail House, 19 Leadenhall Street, London, E.C.3, to which all departments are moving. The telephone number is now Mincing Lane 3361; the telegraphic address remains as "Avgen Stock, London."

MISSILE PROJECT.—Among the companies reported to be preparing proposals for the U.S.A.F.'s Bold Orion ASM project are Martin, Bell, Lockheed, Douglas, General Electric, North American, Boeing, Northrop and Thiokol. The missile is to have a solid-propellent rocket powerplant and could be launched by a B-58 Hustler or the proposed 2,000-m.p.h. North American B-70. The selection of a company to develop the missile is expected in the middle of this year.

TWO-STAGE ATLAS. — Convair-Astronautics has received a U.S.A.F. contract to develop an upper stage for a modified Atlas; this could put a 5-ton satellite into orbit or send smaller vehicles as far as Mars or Venus. Pratt & Whitney will develop the high-energy liquid-fuel rocket motor for the second stage.

Gas-turbine Courses

THE Department of Aircraft Propulsion, College of Aeronautics, Cranfield, is to hold short courses on aircraft gas turbines, primarily for research-development and design personnel. The first will be of three weeks' duration, starting on March 2; others will be announced later. The emphasis will be on design aspects.

Courses will be much the same as those of the aero-engine design courses until recently held at the School of Gas Turbine Technology, Farnborough.

Further details from the College at Cranfield, Bletchley, Bucks.

SUPPRESSED.—The Martin Co. has developed a new portable jet-engine noise-suppressor for the SeaMaster, using the principle whereby noise is converted from low-frequency to high-frequency.

Howard Levy photograph

ARROW TEST-BED?—It is reported that an Avro Arrow may be used by General Electric for testing J93 turbojets.

CELEBRATION IN DENMARK.—Founded as Det Danske Aeronautiske Selskab on January 20, 1909, the Kongelig Dansk Aeroklub (R. Danish Ae. Club) is now celebrating its jubilee. It assumed that title in 1925.

CANADIAN ROCKETRY.—According to Canada's Defence Research Board the first Canadian-developed upper-atmosphere research rocket should be launched this year.

NARDI PRODUCTION.—A batch of 25 Nardi FN.333 amphibians is to be built. This aircraft, development of which began in 1952, has recently received Italian and U.S. C.s of A. for a maximum gross weight of 2,975 lb.

U.S. MANNED SATELLITE.—The NASA has given the McDonnell Aircraft Corpn. a contract worth more than £5 million for the development of a satellite capsule to be used in Project Mercury, the manned space-flight programme. It is planned to put the satellite into a near-circular orbit 100-150 miles above the Earth; it will re-enter the atmosphere after 24 hr. and land supported by parachutes.

APPROVAL FOR HILLER. — An official type certificate for the Hiller 12E three-seat helicopter has been awarded by the Federal Aviation Agency. This type has a 305-h.p. Lycoming engine and for a loaded weight of 2,700 lb. carries a useful load of 1,000 lb. It has a 16,200-ft. ceiling and a hovering ceiling of 9,500 ft.

GRAVINER IN GERMANY.—Deugra Gesellschaft fur Brandschutzsysteme m.b.H., has been formed by the Graviner Manufacturing Co., Ltd., to look after that company's interests in Germany. The new company is entirely Graviner-owned; its address is Breite Strasse 3, Düsseldorf.

PRODUCTION AT BELFAST.—English Electric Canberra PR.9s are being built at Queen's Island for the R.A.F. This picture shows one of the final-assembly bays of Short Brothers and Harland.

Commercial Aviation Affairs

BLACKPOOL-DUBLIN. — The first direct air service between Blackpool and Dublin will be started by Silver City's Northern Division in the spring. It will be operated, at frequencies of one or more a day, on Fridays, Saturdays and Sundays, with 36-seat DC-3s and 16-seat Herons.

DOPPLER FOR K.L.M.—Canadian Marconi have received an order for their Doppler navigation equipment from K.L.M. for installation in the DC-8s which are due to enter service early next year.

TURBOJET PILOTS' PAY.—BALPA is demanding an "immediate and substantial" salary increase for pilots of turbojet transports. Present pilots' salaries are based on a 1956 formula.

INDIAN NEGOTIATIONS. — A British delegation led by Mr. A. H. Wilson of the M.T.C.A. arrived in India on January 12, to negotiate a new civil aviation agreement between India and the U.K. Air services between the two countries are operated at present under a two-year agreement which expires in March.

MOSCOW IN SERVICE. — The Ilyushin Il-18 Moscow turboprop has been put into service by Aeroflot on a Moscow-Khabarovsk freight service. The 5,200-mile route is flown in about 14 hours.

NOVEMBER TRAFFIC.—Provisional M.T.C.A. figures show that the traffic of the U.K. airlines on scheduled and inclusive-tour services in November increased by 1% over November, 1957. The results, like those for October, were influenced by the B.O.A.C. strike; excluding B.O.A.C. the traffic increase was of the order of 9%. Apart from October when traffic fell by 4%, the November result was the worst for six months.

S.A.S. CARAVELLE PLANS. — Scandinavian Airlines System has confirmed that it will introduce Caravelles on its European and Middle East routes on May 15, at the same time as Air France. S.A.S. has 16 Caravelles on order of which four will be leased to Swissair. The airline plans to serve the following cities with the Caravelle during the summer of 1959; Copenhagen, Stockholm, Helsinki, Dusseldorf, Stuttgart, Munich, Vienna, Prague, Budapest, Geneva, Milan, Rome, Athens, Istanbul, Ankara, Beirut, Damascus, Baghdad, Basra, Teheran, Abadan, Kuwait, Cairo and Khartoum.

OWNERS MEET.—The A.G.M. of the Aerodrome Owners Association is to be held on February 25 at 19 Park Lane, London, W.1, at 15.00 hrs. It will be followed by the annual dinner at the Hyde Park Hotel at 19.00 for 19.30 hrs.

ELIZABETHAN DEMONSTRATED. A B.E.A. Elizabethan under the command of Captain John Clements was recently demonstrated to King Hussein of Jordan at Amman, and to a number of Lebanese operators on its return flight.

HELP FOR HUNTING-CLAN.—The Export-Import Bank in Washington has approved a $1 million five-year loan to Clanair, representing 60% of the total purchase price (with spares) of one of their two DC-6As.

FIFTH FREEDOM FOR FRANCE.—Protracted negotiations between the Canadian and French Governments have been concluded with the granting to Air France of Fifth Freedom rights between Montreal and Chicago. The airline has been flying a thrice-weekly service between Paris and Chicago via Montreal for the past four years.

PAKISTAN PLANNING. — The Pakistan Government has set up a committee to advise it on the internal and international operations of Pakistan International Airlines and to suggest improvements in the organization to meet P.I.A.'s present and future requirements.

DC-3s FOR DOVES.—Mac.Robertson Miller Airlines are to replace their three remaining D.H. Doves, which are now of too small capacity for the traffic, with DC-3s. Two Doves were sold by Mac. Robertson three years ago and one of the remaining three has already been sold to the Royal Flying Doctor Service for use in the Kimberleys in north-west Australia.

AER LINGUS EXPANSION.—France has granted Aer Lingus permission to extend its service from Dublin through Paris to Lisbon and Zurich.

P.A.W.A. AND THE COMET.—It has been known for some time within the industry that Pan American were interested in the Comet 4 for possible use on Central and South American services. This interest has now been reported in the *Financial Times*.

MORE TO MOSCOW.—Approval has been given for an increase, from one to two per week, in the number of K.L.M. return services between Amsterdam and Moscow. The extra services will be operated from April 1.

J.A.L. EXTENSIONS.—Subject to agreement between the Japanese authorities and the United States C.A.B., Japan Air Lines will start services (three per week with DC-7Cs) to Los Angeles, via Honolulu, on May 1 and on June 1 (twice a week) to Seattle, for which traffic rights are already held. J.A.L., which already operates to and from San Francisco, will then become the only airline flying between the Orient and all three U.S. West Coast gateways. DC-8s, of which J.A.L. have four on order, will replace present equipment on these routes during 1960.

ANSETT-ANA IN LONDON.—An office is to be opened in London by Ansett-ANA, Australia's biggest private airline. Mr. A. C. H. Petherick, previously the manager in South Australia, will be in charge.

YEADON SETTLEMENT. — Agreement has now been reached between Yeadon Aviation, Ltd., and Leeds and Bradford Corporations for the settlement of all claims by the company in connection with the take-over by the municipalities of the aerodrome which became effective on January 8.

PILOT BLAMED.—A C.A.B. report on the mid-air collision between a Capital Airlines Viscount and an Air National Guard T-33 blames the accident on the pilot of the T-33 for his failure "to exercise proper and adequate vigilance to see and avoid other traffic."

ARGENTINE LOSS.—A C-46 owned by the new operator, Austral, crashed into the sea at Mar del Plata on the night of January 16. All but one of the 51 occupants lost their lives. The aircraft was inaugurating a new service.

FIRST INTERCONTINENTAL.—On January 11 the first of the Boeing 707 Intercontinentals made its initial flight from Renton to Boeing Field, Seattle, where the test programme started on January 12. It is seen here taking off on its ferry flight from Renton. This aircraft is a 707-321, due eventually for Pan American World Airways.

News About People

R.S.A. AWARD.—The Benjamin Franklin Medal for 1959 has been awarded to Mr. Henry G. Nelson, M.A., M.I.C.E., M.I.Mech.E., M.I.E.E., managing director of the English Electric Co., Ltd., "for his work in scientific industrial development." The award is made annually by the Royal Society of Arts "to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufactures and commerce."

AIR TRAINERS.—Mr. C. Malec, head of the sales and services division of Air Trainers Link, Ltd., has resigned his post with effect from January 1. On February 1 Mr. N. J. C. Hill takes over control of the division and Capt. D. Wilson has become sales manager of the company.

VICKERS ORGANIZATION.—Following the recent changes in the design organization of Vickers-Armstrongs (Aircraft), Ltd., the Weybridge Works

appointments of Mr. K. S. Lawson, B.Sc., D.I.C., A.F.R.Ae.S., chief aerodynamicist (left), and of Mr. H. Zeffert, A.F.R.Ae.S., A.I.E.E., M.A.I.E.E., chief electrical engineer (right), will become aircraft company appointments. Mr. J. R. Leach, flight-test manager, continues to be responsible for aircraft company flight-test activities.

MARTIN ELECTRONICS. — Mr. John M. Pearce, formerly vice-president and general manager of the Hoover Electronics Co., has been appointed manager of electronics requirements of the Martin Co. Manufacture of missiles, associated equipment and electronics systems now constitutes about 70% of the company's business at the Baltimore, Denver and Orlando divisions.

AIR LEAGUE CHANGES.—The Duke of Hamilton and Brandon, K.T., G.C.V.O., A.F.C., is to become President of the Air League of the British Empire in succession to the Rt. Hon. the Viscount Thurso of Ulster, K.T., P.C., C.M.G., LL.D., who has retired for health reasons. Air Chief Marshal Sir Francis Fogarty, G.B.E., K.C.B., D.F.C., A.F.C., has become the new chairman of the Air League succeeding Air Chief Marshal Sir George Pirie, K.C.B., K.B.E., M.C., D.F.C., LL.D.

ELECTRONICS SECRETARY.—Mr. A. S. Marshal has been appointed to the new post of deputy secretary of the Electronic Engineering Association. Since 1937 he has served as an observer in the Fleet Air Arm and at Admiralty radio and research establishments.

FIRTH CLEVELAND.—Mr. J. A. Hayward, who has been a director of the Firth Cleveland Group in South Africa, the West Indies, the U.S.A. and Canada, is now also appointed to the board of Firth Cleveland, Ltd., of London, S.W.1, of which Mr. C. W. Hayward is chairman and managing director.

NATO COMMAND. — Gen. T. Anderson of the R. Danish A.F. is to command the NATO North Region Air Command, in succession to Gen. N. D. Sillin, U.S.A.F. This is the first appointment of a non-American officer to the post.

SAFETY APPOINTMENT. — Mr. Ansel E. Talbert has been elected vice-president of the Flight Safety Foundation, Inc. Mr. Talbert, an aviation journalist of long standing, will act as executive editor of more than 10 regular publications and reports published by the foundation.

APPRENTICE AWARD.—Sir Ronald Nesbitt-Hawes, education adviser to the English Electric Group, presents the J. R. Harwood Apprentice Award to Mr. J. A. Painter, the best student apprentice of 1958 at the Group's Warton aerodrome. The training of each student and graduate apprentice costs the Group about £2,000.

R.A.N. APPOINTMENT.—Capt. T. K. Morrison, O.B.E., D.S.C., R.A.N., has taken over command of the Australian carrier "Melbourne" from Capt. O. H. Becher, D.S.O., D.S.C., R.A.N.

T.W.A. APPOINTMENTS.—Mr. Gustave Barnett has been appointed cargo sales manager for T.W.A. in the U.K. At the same time the airline has announced the appointment of Mr. John Cooper as its sales promotion manager in the U.K.

I.A.L. POST.—Lieut. Cdr. C. H. Pain, R.N. (Retd.), has joined the managerial staff of International Aeradio (Caribbean), Ltd., at Port of Spain, Trinidad.

Military Aviation Affairs

GHANA AIR FORCE. — Dr. Nkrumah, Prime Minister of Ghana, announced last week that his country was to have an air force. Two Indian Air Force officers are being seconded to Accra to aid in its establishment. No indication of equipment has been given.

HUSTLER ORDER.—A contract for 36 Convair B-58 Hustlers placed by the U.S.A.F. brings to 66 the total purchased to date. Another 40 will be purchased with fiscal 1960 funds according to present plans. Newest model B-58 has more range and higher cruising speed than original versions.

AUSTRALIAN MISSILE STUDIES.—An Australian team consisting of three R.A.A.F. officers and a defence scientist arrived in the U.K. on January 19 at the start of a tour to study the latest developments in guided weapons in this country and the U.S. Inquiries by the team will guide the Australian Government in selecting surface-to-air guided weapons for future use by the Australian Defence Forces. Australia already has good knowledge on the performance of British missiles through work at Woomera.

ITALIAN ROTORCRAFT.—The first of a number of Sikorsky S-58s for service with the Italian Navy is due to be delivered this month.

R.A.A.F. HERCULES.—A further four of the 12 Lockheed C-130 Hercules transports ordered for the R.A.A.F. arrived at Richmond, N.S.W., on January 5.

SPARROW III AAMs.—Fighter aircraft on board the U.S.S. "Midway" and U.S.S. "Bonne Homme Richard" have been armed with Sparrow III AAMs. Both carriers are serving with the U.S. Seventh Fleet in the Western Pacific.

QUICK LOADING.—At a recent demonstration at Travis A.F.B., Calif., 52,000 lb. of cargo was loaded into a Douglas C-133A Cargomaster in 1 hr. 10 min. The cargo was unloaded in 50 min. by five men and a fork-lift truck.

EUROPEAN SERVICE.—The F-102A Delta Dagger is to go into service with U.S.A.F.E. squadrons in the near future. It is intended to replace certain Sabre-equipped squadrons of the 86th Fighter Wing at Ramstein, Germany, with the F-102A.

NAVAL PILOTS.—Vice-Admiral Sir Walter Couchman, Flag Officer Air (Home), is to be the reviewing officer at the passing-out parade of Fleet Air Arm pilots at No. 1 F.T.S., R.A.F. Linton-on-Ouse, today. On the graduating course is the first Royal Marines officer to be trained at the station.

U.S.S. "INDEPENDENCE." — The fourth of the "Forrestal" class of U.S. carriers—the "Independence" — was commissioned at the Brooklyn naval shipyard on January 9. Built at a cost of $190 million, the 60,000-ton carrier will have a complement of 4,142 men, and her strike force will include 100 aircraft, most of them jet bombers capable of delivering atomic weapons.

Air Transport

Short-Range Navigation-aid Policy

AT the ICAO conference on navigation aids in Montreal next month, convened to "reach conclusions on short-distance aids, including consideration of any relationship of these aids to other elements of the air navigation system as a whole," the United Kingdom is to propose that the Decca Navigator should be adopted by the Organization as a standard international short-range radio-navigation aid. This follows the repeatedly expressed M.T.C.A. view that the aid is the only navigation system which is sufficiently accurate and flexible to keep rapidly growing air traffic moving smoothly and quickly along the U.K. airways and in control areas.

For the ICAO meeting the M.T.C.A. has prepared a document on the U.K. views and aims on the subject of radio-navigation and this brings together many of the arguments already advanced. In these the U.K. is convinced that many of the ATC problems could be solved by the use of a high-accuracy hyperbolic navigation system. In addition, it will be suggested that Dectra should eventually be adopted as the standard long-distance aid in those areas where it is required to provide the more accurate ground reference guidance needed to meet the requirements of control.

Nevertheless, the U.K. recognizes and supports the view that in many areas the present ICAO standard aid, VOR (visual omni-range), could provide all the guidance necessary for the navigation and control of aircraft for a number of years to come. But it is equally clear that in some busy terminal areas and complex airways patterns the rigidity of the point-source aid restricts the capability of the ATC system to provide the number of flight paths necessary to achieve an optimum traffic flow. For this reason, inflexible procedures and unwieldy routeings have to be introduced.

It is, of course, possible to increase the capacity of a single airway by reducing the longitudinal separation, and this country was one of the first to do this on a regular basis. The continued use of radar has enabled ATC to handle a much larger volume of traffic than would have been possible using procedural separation standards.

The U.K. fears that a decision to standardize DMET (the DME element of Tacan) at the Montreal meeting will lead countries so far into the web of the Rho/Theta concept that it will become almost impossible to disentangle. Countries must face the possibility that the failure of VOR/DMET to handle the traffic might lead to a demand for more accurate azimuth guidance of Tacan and for an ever-increasing reliance upon the radar controller to overcome the basic deficiencies of the point-source system.

There is also a U.K. belief that the present unsatisfactory state of affairs has come about because some countries (i.e., the U.S.A.) have placed too great an emphasis on the need for a common civil/military navigation system. This has tended to override the true operational requirements of World-wide civil aviation. These requirements are today dictated in the main by ATC considerations, particularly in areas of high-density traffic where controlled airspace for civil use is limited and by the more stringent operating characteristics of the various types of turbine-powered transports now entering service.

The ICAO Jet Operations Requirements Panel recommendation, for "the adoption of an accurate and reliable short-range navaid based on an area-coverage system and designed to provide pictorial presentation to the pilot in the cockpit" is endorsed by this country, which is also convinced that the operation of turboprop and turbojet transports accentuate the need for an aid which will:—

(a) Reduce lateral as well as longitudinal separation minima;
(b) Enable a greater use to be made of lateral separation in order to provide the greatest possible freedom in the vertical plane;
(c) Be capable of serving any air route configuration without the costly, lengthy and difficult process of redeployment of ground facilities;
(d) Give the required quality of short-distance navigational service over sea areas;
(e) Permit flexibility in the siting of holding patterns and economy in their size;
(f) Enable pilots to make smooth and accurate approaches to both instrument and non-instrument runways;
(g) Provide accurate navigational information to helicopters as well as to high-flying turbojet aircraft;
(h) Provide the pilot with a continuous and accurate presentation of his position in a manner which will enable him to follow the desired track during all stages of flight;
(i) Be capable of integration with long-distance navigational aids so as to facilitate the implementation of additional equipment on a progressive basis as the requirements develop;
(j) Be easy to site and maintain;
(k) Require no regular air calibration checks;
(l) Provide a high coverage/cost ratio.

Extensive trials of the Decca and Dectra systems have shown that they have the flexibility and accuracy necessary to meet the most exacting ATC requirements and that they are capable of further development to provide such refinements as automatic flight control and automatic air/ground position reporting. The form of pictorial presentation common to these systems is also compatible with the Doppler system and can be used to display navigational information from all or any of these sources. The policy advocated by the U.K. will protect existing VOR and Doppler investments, make full use of the extensive Decca/Dectra coverage already available and lead, eventually, to a fully integrated World-wide system.

FIRST FOR THE ARGENTINE.—At Hatfield last week-end the first of the initial batch of three Comet 4s for Aerolineas Argentinas was rolled out and should be delivered before the end of next month. The second series of three Comets for the Argentine airline are due for delivery in 1960.

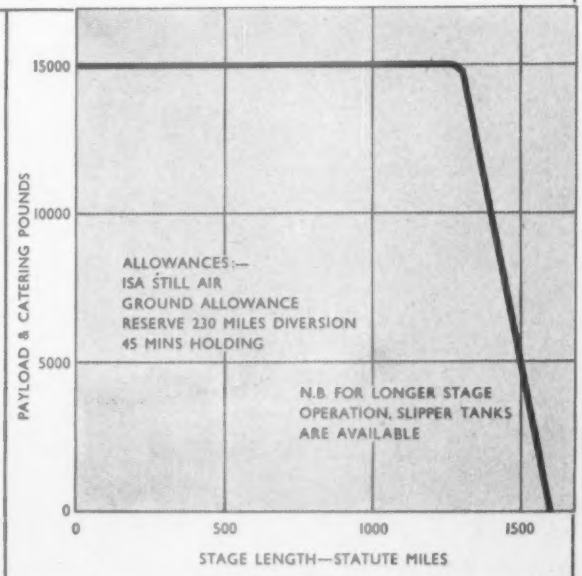
Photograph copyright "The Aeroplane"

That's another impressive point about the VISCOUNT

Since the original Viscount 810 design, both its payload and range have been increased. That means even higher density operation and, of course, lower operating costs. The graph speaks for itself. The results are even more impressive. Seat-mile costs can be reduced by more than 10% on all stages. On long haul the saving is up to 23%. In terms of earning power this gives an increase of 15% to 30% according to range.

More impressive facts about the VISCOUNT 810

- Take-off weight now 72,500 lb (up 3,500 lb)
- Landing weight, zero fuel weight and payload all increased by 2,000 lb
- Maximum-payload range increased from 800 to over 1,200 miles
- 365 m.p.h. cruising speed. When re-engined with more powerful Darts, 400 m.p.h.
- Backed by Vickers/Rolls-Royce jet-prop experience of over 300 Viscounts in service with 40 airlines
- Viscount 810 is already in service with or on order for Continental Air Lines, Lufthansa, South African Airways, Ansett-A.N.A., Airwork, Cubana, Hunting-Clan, Pakistan International Airlines, T.A.A. and V.A.S.P.



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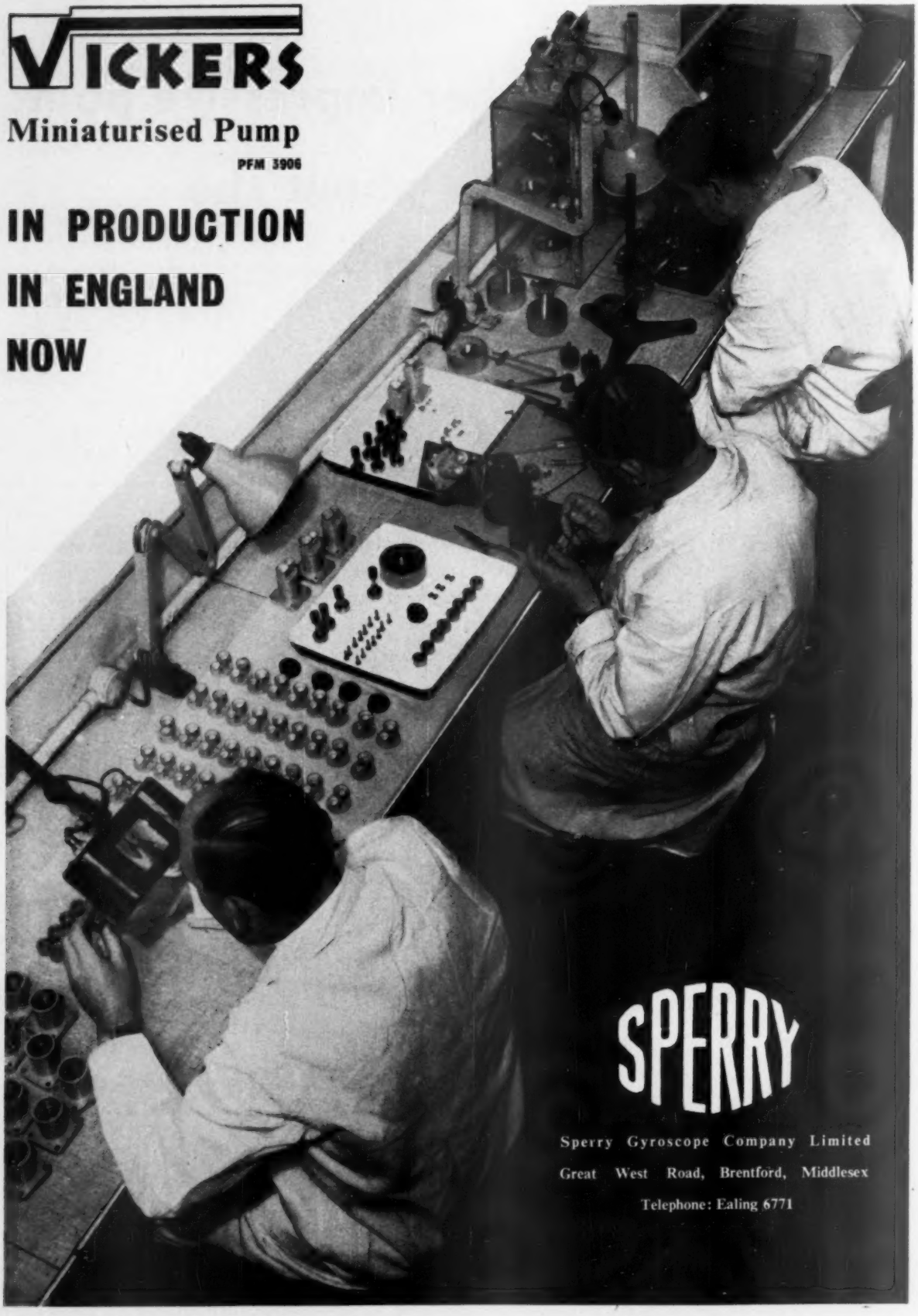

SPERRY

Sperry Gyroscope Company Limited

Great West Road, Brentford, Middlesex

Telephone: Ealing 6771

Those Three-hand Altimeters

CLUES leading to the possible cause of the Britannia 312 accident near Hurn on December 24—as well as support for the declared cause of the C.A.A. Viscount accident near Benina—are provided (in reverse, so to speak) by a less tragic series of incidents described in the January issue of *Approach*, the U.S. Naval Aviation Safety Review.

The pilots in a TV-2 turbojet trainer (alias Lockheed T-33) were given number one to land and, after making a turn for successful positive identification on the GCA display, turned on to downwind, base and final approach legs. At the start of the final approach GCA lost the aircraft echo and they were waved-off. After three more approach attempts with the same results and with the knowledge that the weather at the alternate was even worse, the situation in the two cockpits of the TV-2 was "disintegrating into a welter of confusion, puzzlement and hysteria."

On a fifth attempt with the same result the pilot-in-charge decided to descend to 200 ft. where, according to the weather actuals, they should have been visual. At that altitude they found they were still in cloud and the same stunning thought struck the occupants of both cockpits: they had been misreading their altimeters and were at 10,200 ft. instead of 200 ft.

They got down safely after losing their excess 10,000 ft.—but there was only about 100 lb. of fuel left in the tanks of the TV-2 at shut-down.

The First Market Report

THIRTY-SEVEN quotations for a total of 110 aircraft were received by the Aircraft Exchange in its first week of operation in New York (see THE AEROPLANE, December 19 and 26, 1958). The first *Market Report* issued by the Exchange, on January 8, shows the highest bids and lowest offers for various types of aircraft, and also lists the approximate "last known" actual prices, second-hand or new, for most current transports. A distinct buyers' market for piston-engined aircraft is shown to exist, as expected.

The Exchange is concerned with bids or offers for outright purchase or sale, or for leasing arrangements. Only two bids are recorded: one for purchase of a single Convair 340 at $300,000 and one for the lease of a DC-6A for two years from January, 1960, at $20,000 per month. The nearest approach to the Convair 340 bid, incidentally, was an "incomplete" quotation of $400,000.

For the most part the aircraft offered for sale are in used condition, including Bristol 170/21, Convair 240 and 340, Curtiss C-46, Douglas DC-3, DC-4 and DC-6 variants, Constellation variants, and Martin 404. Listed as new are two Fairchild F-27s offered at $575,000 each; these are probably the aircraft ordered by Wheeler Airlines in Canada, which this airline has now decided not to put into service.

A wide scatter of prices is apparent in the offers. For instance, two DC-3s were available at $50,000 each; another, with executive interior, had a price tag of $250,000. Similarly, DC-6s varied from $600,000 to $860,000 (for a DC-6A) and $850,000 (for a DC-6B). Several offers were for bulk quantities, ranging up to 22 Convair 240s and 22 DC-3s.

Although none of the newer types of transport figure in the Exchange dealings, it is of interest to record the last known actual prices listed in the report as follows (in thousands of U.S. dollars): Boeing 707-120, $4,700; Boeing 707-320, $5,000; Boeing 720, $3,500; Britannia 300, $3,000; Convair 600, $4,050; Convair 880, $3,650; Comet 4, $3,200; Caravelle, $2,200.

The Friendship at L.A.P.

SINCE Aer Lingus' F-27 Friendships will not normally be operating into London Airport, it was natural, perhaps, that this should have been the last of the series of airports in the U.K. at which demonstrations have been made. January 13, the day of these demonstrations, was by way of being a lucky one for Aer Lingus; in spite of, at times, fairly marginal conditions in terms of visibility, everything went according to plan and three passenger loads were flown before the visibility clamped finally for the night and prevented the aircraft's return to Dublin.

For ourselves, on the first of these flights which left soon after 11.00 hrs. it was found that, once the "corner" had been turned at the Epsom range, visibility improved quite considerably. It was possible, during most of the 40-minute period of the demonstration, to enjoy a view of a snow-covered Kent landscape from the deep windows of the Friendship and to appreciate once again—after the days of the Ambassador-Elizabethan—the advantages of the high-wing layout from the passenger's point of view.

The F-27 might be described as a small aeroplane which gives the passenger all the impressions of a large one—and with the advantage that five-seat rows are not practically possible. For those with experience of both aircraft, it might be said to be something of a cross between the Elizabethan and the Viscount—with the high-wing advantage of the former and the turbine advantages of the latter. Certainly the passengers in the seat-rows towards the rear of the fuselage will consider it to be superior to both in quietness and smoothness.

The Aer Lingus Friendships are normally laid out for 36 passengers in nine seat-rows, but up to 40 passengers (or, by moving the bulkhead, mixed passenger-freight loads) can be carried. They are laid out on the flight deck for two-crew operation with a jump seat for training and other purposes. The flight equipment includes Collins radio and flight system and one of the more impressive features of the control cabin is the depth and position of the screen panels—making it unnecessary to have the "peep" windows which are becoming a standard feature in the roof of the larger pressurized transports.

Three F-27s have now been delivered and the first service with the new equipment was started on December 15 on the Dublin-Glasgow run. The remaining four will be delivered by April so that, this summer, all Aer Lingus scheduled services will be flown with turboprop aircraft. DC-3s will be retained only for charter and freight operations. As already recorded Aer Lingus has ordered three more 60-seat Viscount 808s to

LONDON VISITOR.—This Fokker Friendship was demonstrated by Aer Lingus at London Airport last week, completing a series of such demonstrations at various cities in the U.K. Aer Lingus will continue to use the Viscount 808 on the Dublin-London service, but the Friendship is replacing the DC-3s and Viscount 707s on other routes to the U.K.

Photograph copyright "The Aeroplane"

supplement the three which have been in service since early in 1958, and the first of these was delivered this month. The four V.707s, which have been in service with Aer Lingus since 1954, are to be sold along with the four DC-3s which are surplus to charter requirements.

The F-27 not only has Dart powerplants, like the V.800, but, it seems, has a cruising speed which is sufficiently similar for the smaller aircraft to be able to maintain the same schedules. The two aircraft can, therefore, be directly complementary on routes where either type of aircraft may be used to meet peak-traffic or through-traffic conditions. Certainly the passengers are going to like Aer Lingus' new equipment—and so, one gathers, will the flight crews who have not yet had experience of the type.—H.A.T.

Avro's Civil Venture

Some thoughts on the design philosophy of the Avro 748, a Dart-engined feeder-liner for 1961.

UNTIL the makers are ready to give more complete details of the Type 748 feeder-liner, Avro's new venture into the civil aircraft market, announced last week, can be discussed in only the most general of terms. Enough has been said, however, to show that Hawker Siddeley's Aviation Division has been impressed, like so many others before it, by the prospects of the "DC-3 replacement" market. Whilst it is true that there are still many hundreds of DC-3s in service throughout the World for which no replacements have been ordered, Avro's decision brings their new project into direct competition with several other existing types.

It might have seemed wiser, therefore, for a company making a bid to re-enter the civil market to choose a more sparsely populated area, even if such a venture were more speculative. For instance, both the small, short-haul jet transport and the simple, ultra-low-cost utility air-bus are worth a close look at the present time. However, the Avro die has been cast—and the decision has been influenced by a market investigation which has indicated the need for another aeroplane in the same category as the Fokker/Fairchild F-27 Friendship, Handley Page Herald, Grumman Gulfstream and the Japanese YS-11 all powered, like the Avro 748, by two Rolls-Royce Darts. Some relevant data for these four types—of which the Friendship is in production and service, the Herald and Gulfstream are in flight test and the YS-11 is to fly in 1962—are shown in the accompanying table.

Where can the Avro 748 fit into this spectrum, and what does it offer to justify the makers' willingness to gamble, one supposes, several million pounds on it as a private venture? The answer appears to be in the related areas of performance and cost, in both of which respects Avro expect to be able to improve on their rivals by starting later and, therefore, taking advantage of latest techniques and a knowledge of operators' particular requirements not fulfilled by the existing types.

As the table shows, the YS-11 is rather larger than the other types considered, and the Gulfstream is designed, after a thorough market survey, for the U.S. business market and therefore does not compete directly. So the F-27 and the Dart-Herald are the real rivals of the Avro 748. Compared with these two types, the 748 is a low-wing design, and can therefore be expected to have a rather lower weight for a given payload-range configuration. This natural advantage of the low wing design will be enhanced by use of a simple lightweight structure—and by keeping the optimum range to a minimum.

Designing for a range with max. payload of, say, only 200-300 miles would have a beneficial influence on gross weight—and therefore on performance, first cost and operating costs. To design down to this range will require considerable courage, although there is evidence—again supported, no doubt, by Avro's own surveys—that a sizeable portion of the World's air traffic moves over very short stages. In Europe, for instance, very nearly half of the total air traffic effort is concerned with sectors of less than 400 miles. Although most of these sectors are at present flown by longer haul equipment which most operators require for at least a few of their routes, if the really short-haul aeroplane can be made sufficiently attractive in cost, it might well carve for itself a useful niche in the market.

	F-27	Herald	Gulfstream	YS-11
Wing position	High	High	Low	Low
Dart	R.Da.6 or *, 1,720 or 2,100 e.h.p.	R.Da.7, 2,100 e.h.p.	R.Da.7, 2,100 e.h.p.	R.Da.10, 2,655 e.h.p.
Span	95 ft. 2 in.	94 ft. 9½ in.	78 ft. 6 in.	105 ft.
Gross weight	35,700 lb.	37,000 lb.	31,000 lb.	40,000 lb.
Max. payload	9,000 lb.	10,160 lb.	3,780 lb.	—
Passenger capacity	40-44	36-47	10-25	60
Cruising speed	260 k.	241 k.	304 k.	264 k.
Range with max. payload	590 n.m.	610 n.m.	1,565 n.m.	600 n.m.
First cost: in U.S.A.	$635,000	—	$700,000†	—
: in Europe	£219,000*	£185,000	—	—

* 2.3 million guilders at 10.5 to the £. † Bare airframe.

If Avro have argued along these lines, as seems likely, the 748 will certainly use the Dart in its R.Da.6 version, since this will offer enough power for the gross weights involved and is already "lifed" at 2,000 hours between overhauls. It would then be logical for Avro to buy the Viscount powerplant design—as Armstrong Whitworth did for the Argosy—but to couple it, perhaps, with the larger-diameter Rotol propeller and gearbox used on the Friendship.

With this power and a gross weight of, say, 30,000 lb., the Avro 748 should have a superior take-off and 2nd-segment climb performance to its rivals. An aeroplane of this size which can genuinely operate without penalty from second-class DC-3-size airfields in high altitudes and hot temperatures whilst complying with current B.C.A.R. and C.A.R. regulations will interest many operators, not least in South America and—as we said last week—in India.

Taking advantage of present-day knowledge, the Avro 748 can be expected to have a multiple-load-path, fail-safe structure with a safe-life of at least 30,000 hr. Since the kind of operator the company seems to have in mind is often a small one in the more remote areas, with the minimum of facilities for maintenance and repair, the Avro 748 will need to be as simple as possible, both in structure and systems. The designers no doubt have eschewed the more advanced structural techniques, such as metal bonding, which, although attractive, complicate the repair schemes, especially if fail-safe characteristics are to be maintained. Similarly, to reduce cost and save time, existing items of equipment could be used "off-the-shelf" wherever possible, with electrics and hydraulics kept to a minimum. This in turn would simplify maintenance and help to keep operating costs down.

It remains for Avro to demonstrate their declared intention of flying the first 748 early in 1960. If this first target date can be achieved and can be followed by speedy certification, the new aircraft could presumably be offered for service before the end of 1961. Success will then depend on the company's ability to align itself with the particular—and at times peculiar—demands of civil aircraft marketing, coupled with some degree of sponsorship for the type by one of the major British airlines. Without such sponsorship, no major post-War British transport design has received export orders. In the case of the 748, it could conceivably come from the R.A.F., who might find in it a successor to the Anson/Heron/Pembroke and a partner for the Argosy. But military or civil, the sponsorship must be offered at an early stage in development if it is to be of real help to this bold but reasoned bid to produce an exportable aeroplane.—F.G.S.

South American airlines, writes Frederico B. Kirbus—

Squabble in the Sun

ONE of the World's few profit-showing airlines tumbled precipitously back into the red two months ago when Panagra (Pan American-Grace Airways, Inc.), largest carrier linking both halves of the New World, was forced to ask Uncle Sam to dip into his pocket for a subsidy to offset falling traffic revenue and more and more empty seats on its DC-7Cs.

What forced Juan Trippe's giant baby to get into the Washington breadline wasn't competition from another massive 100-airliner organization, but from a buzzing swarm of shoestring operators flying the flags of practically every Republic in South America. In fact, this proliferation of small fry who buy up second-hand C-54s and C-46s and schedule all sorts of runs from short hops to cross-continent flights, is the outstanding phenomenon of post-War commercial flying in South America. There is a rich market under the Southern Cross, where distances are great, roads poor, railways worse; where the heat of summer makes extended train rides seem like something cooked up by Dante in a light-hearted mood, and where the endlessly dull scenery makes looking out of windows stale, flat and unprofitable.

However, this market can only be won by slashing costs and offering air travel for the poor man, but in a big way. This is what the multitude of independents is doing; what the big carriers can't fight because they're wound up in their own IATA hamstrings. Air travel is not cheap, but in the sophisticated European and North American markets, artificial factors kick fares up higher than need be. Americans travel by air because of their high standard of living; Europeans because they can afford it. On the other hand, South Americans don't travel more by air because they *can't* afford it. In the century of the common man, what José González needs is air transportation for the common man.

The biggest item in this equation is fares. Where the non-IATA carriers are gouging out the big boys is in the amount of U.S. dollars plunked down by dark-skinned hands on airline counters from the Rio Grande to Tierra del Fuego. IATA wants $458.80 tourist between Buenos Aires and New York, and that is what all the federated carriers religiously charge. But Señor González doesn't give a darn whether he's flying under IATA wings or not when he sees that there are other carriers which will take him for $351.20. This fare is charged not by a one DC-3 outfit but by one of the biggest independents in the World—REAL S.A. of Brazil, operating three DC-4s in addition to 16 Convairs, 18 C-46s and 78 DC-3s. Still too expensive? Cinta Chilean Airlines will DC-4 you from Santiago de Chile to New York for $280.40. Santiago is almost the same distance from New York as is Buenos Aires, so the comparison is to all intents and purposes direct. TAN-APSA of Honduras are ferrying as many passengers as they can carry on a DC-6 (called "Super DC-6C" by the airline) between Buenos Aires and Miami for a handful of peanuts.

Now seeking a subsidy from the U.S. Government because of falling revenues, Panagra expects to operate DC-8s, in uniformity with P.A.A., in 1960.

With fare differentials of this nature, is it any wonder that America's greats are screaming for help? Or that the smaller IATA airlines, like Aerolíneas Argentinas, constantly try to block the independents from expanding with the argument that the air travel market is saturated down South American way? It *is* saturated for IATA carriers while the shoestring lines offer commuters a 40% saving in dollars, still the hardest (and hardest-to-get) currency in the World.

However, it isn't so much the zonal traffic drop-off which is hurting the big boys as the constantly smaller chunk of over-the-border pie they are getting. What the small fry really want is not so much operating in their own countries as bleeding off some of the heavy traffic in and out of New York, Miami and other key cities in the United States. Latest independent to try its hand is Argentina's Transcontinental, flying three brand-new Super H Constellations and, furthermore, linked by an agreement with REAL S.A. to offer one flight daily between Buenos Aires and New York, with stop-overs at Montevideo, Rio, Caracas and elsewhere.

Transcontinental operate a different switch on the usual IATA-baiting technique; their fares are equal to IATA tourist

Two of the independent South American operators challenging IATA airlines have ordered Convair 880s—REAL of Brazil and Transcontinental S.A. of Argentina.

services but they offer accommodation almost on a par with IATA's first-class. Their Super Connies carry 82 seats instead of the standard 100, and a bar is provided for cloudborne "quick ones" on the house. Whether this will work or not, however, is anybody's guess. Transcontinental's Constellations are flying pretty empty up to now; that seems to highlight the fact that, as mentioned before, the important thing is low-cost transportation, with comfort a secondary consideration.

Why does the Civil Aeronautics Board give these independents charters to fly in and out of the U.S.A.? That's the sixty-four dollar question which the big lines are asking with more and more emphasis every day. General opinion in informed circles is that the shadowy hand of the State Department's Good Neighbour policy is always in the background. Most of the small South American carriers have the blessing or the direct backing of their respective Governments, and Washington, badly buffeted by Communist howls of imperialism, tells its home carriers to grin and bear it when yet another pint-sized handcart operator comes to draw customers away from the flying supermarkets. One bright spot; the big jets on order may help to turn the tide back to the king-size airlines of U.S.A. Maybe!

At the first Conference of Latin American Air Carriers, held in Montevideo last December, IATA'S envoyés went so far as to publicly bewail the growing importance of non-IATA competition and suggested that it was most important to attract these into the Association. The silent "Oh, Yeahs?" were

audible clear down to Washington, although a very token victory was obtained when Uruguay's PLUNA, which doesn't operate internationally anyway, announced its intention to apply for IATA membership.

The great point now, of course, is How to Fix? As of today it seems that nothing will heal the big boys' headaches except maybe aspirins. The jets will draw off some traffic, but our guess is, not very much. Most of the passengers flying Pan American, Braniff, Aerolíneas Argentinas, etc., today, are either well-off people, Government employees or executives who are obligated to travel by a "name line." These people will appreciate it very much when the DC-8s and Comet Fours slash 12 hours off their flying time. But the man in the street will still have to count his pennies with an eagle's eye. And that eye will inexorably be turned on the airline which takes him more kilometres for less pesos.

Meanwhile, the Republics South of the Border are busily getting ready for jet travel. Argentina has Ezeiza, which doesn't require any extension for the time being, but the other countries, not so happily placed, are working like mad to build new airfields or to lengthen existing runways. Chile's outdated Los Cerrillos is to be shortly replaced by a new, monster field capable of taking anything that can fly. Peru's Limatambo will be complemented by another field in Callao, the seaport of Lima, Peru's capital city. Bogota (Colombia) will have 12,000-ft. runways; Maiquetía (Caracas, Venezuela) is to have a 3,000-ft. facelift; and the Brazilians, feared by early jet operators as the unpredictable king-pins of East Coast operations, are to do things in a typically Brazilian way.

By filling in Guanabara Bay (already partly filled in by shoving a mountain into it) they plan to extend Galeao's runways to accommodate the ponderous jetliners which will, within a few months, be winging their way down to the rich capitals of South America. Prospects, however, are that the Brazilians will be in no hurry to streamline their reception facilities until their own airlines are adequately jet-stocked, which won't be until end-1960.

Best guess, then, is that the mighty blast of the four-jet airliners won't be enough to sweep the shoestring lines off the map for a long time yet. It's a simple question of dollars and cents. Big operators make a fuss about shorter flying times to the U.S.A. Small customers couldn't care less. The only people who are preoccupied about whether their trip will take them 12 hours or 24, are important enough to be travelling on the name lines already. If you fly from Buenos Aires or Santiago to Lima to connect there with one of Lanica's Viscounts, the airline will house you overnight, free of charge, in Lima's swank Savoy Hotel. It'll take you two days instead of one, but who cares? Unless you're a name-line executive with an expense account, you don't want to travel to the U.S.A. for a quick week-end, anyway. It just isn't important.

Many of the non-IATA carriers in South America still use Curtiss C-46s, such as this one of Nicaragua's TAN.

What the big lines are going to do about this, is something we can't even guess. If the jet fare issue caused IATA to crack dangerously at the seams at New Delhi, this South American problem may possibly be the deciding factor to push the Association overboard. The big lines are loudly playing up the safety factor of their first-class ground network. But the hedgehoppers have a very high safety factor, too; avoiding long hauls and flying within sight of emergency fields, they've always got somewhere to touch down if something goes wrong. Ironically, whenever an airliner crash hits the headlines in South America, it's usually an IATA member's machine. . . .

One thing is certain: it will take more than a four-jet Flitgun to kill off the twin-engined mosquitoes buzzing round and round the giant airlines of the Western Hemisphere. The battle will be won, not by higher speeds and free champagne, but lower fares and longer credits for José González to fly today and pay tomorrow.

The Airlines' Shop Window

By James A. Lucas

WITH an ever-increasing number of visitors to the major European airports, it is surprising that the airlines have not converted these centres of attraction into fully dressed shop windows.

Starry-eyed children with their noses pressed against the glass would not be the only customers. Amongst the thousands of visitors to the spectators' enclosures at London Airport (to quote one example) there are many potential passengers for the airlines. Visitors to this airport totalled 846,546 during the season (April to October) last year—and the friends they speak to, on return to their homes as far afield as the Midlands and the South Coast, are also within reach.

Many of the visitors are new-comers to the world of air travel. When they gaze down on the busy scene of an airport apron they are usually captured by the glamour of it all; this is surely the ideal time to encourage their interest and answer their many questions.

Some of the questions will naturally be about the operation of the airport and are the concern of the airport authorities. It is interesting to note that the Ministry of Transport and Civil Aviation is preparing an inexpensive guide-book to London Airport for sale to visitors during the coming season—an example that could be followed by other authorities for their airports.

But if the visitors are to be encouraged to buy airline tickets to the romantic places they hear about (from the usual broadcast commentary on aircraft movements) they may require information which only the airlines can give. The information desk and booking-offices at the airports are often out of bounds to visitors and therefore the need is for on-the-spot information. Booking-offices in spectators' enclosures would probably be unpopular with the airport authorities, but there are other ways of answering the questions while the visitors are in a receptive mood.

Is air travel expensive? How far is it to Rome? What is the flight time to Vienna? These are some of the simple questions. Others—such as: Would I enjoy air travel? Am I likely to be airsick?—are more difficult but not uncommon.

Some effort has already been devoted to this by certain airlines, especially in the form of small exhibitions in the airport buildings. These are excellent, but can be rather expensive if retained for a whole season.

A less expensive medium would be specially prepared posters or leaflets in the appropriate language. These could show a complete route-map giving the distance, fare and flight time for each route—the latter given, perhaps, in Comet-hours, Viscount-hours and so on to suit the airline's existing and future equipment—and illustrations of airliner interiors, with notes on flight experience and the advantages and pleasures of air travel. Only educational publicity is required—flashing neon signs or posters that merely state "Fly so-and-so" cannot answer a single question.

Where the number of visitors is sufficient, an information kiosk could be a useful addition. To reduce cost, this could be shared by all the airlines operating from the airport.

The display material could be pleasantly arranged in the area allocated to visitors. It would be better if these were called spectators' enclosures rather than public enclosures—as it does help if visitors appreciate that at least some members of the public travel by air (not just film stars and expense accounts).

With only one year to go, no time must be lost if these visitors (and their friends) are to be reached and to help in making the 1960s the age of "air travel for all."

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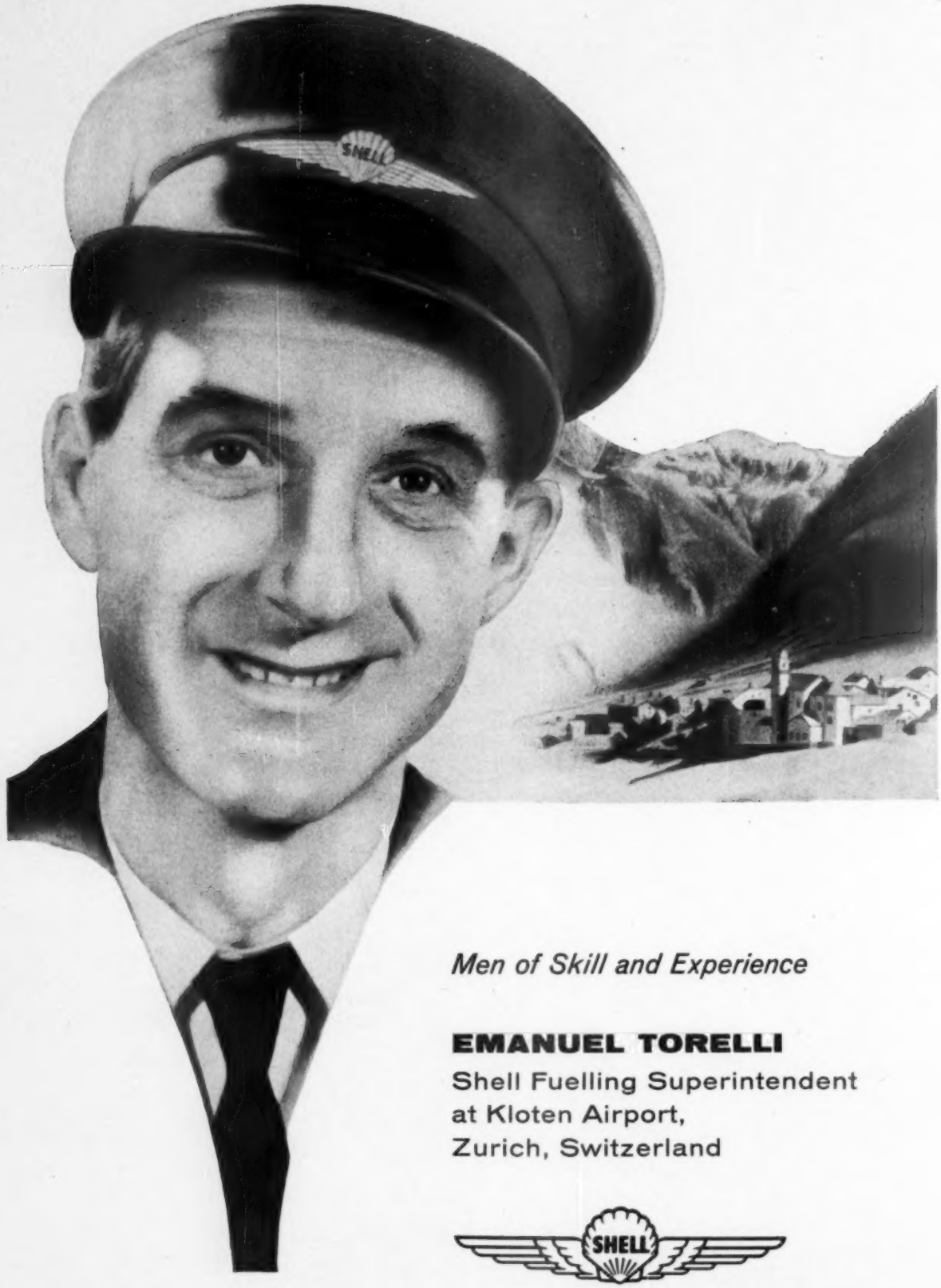


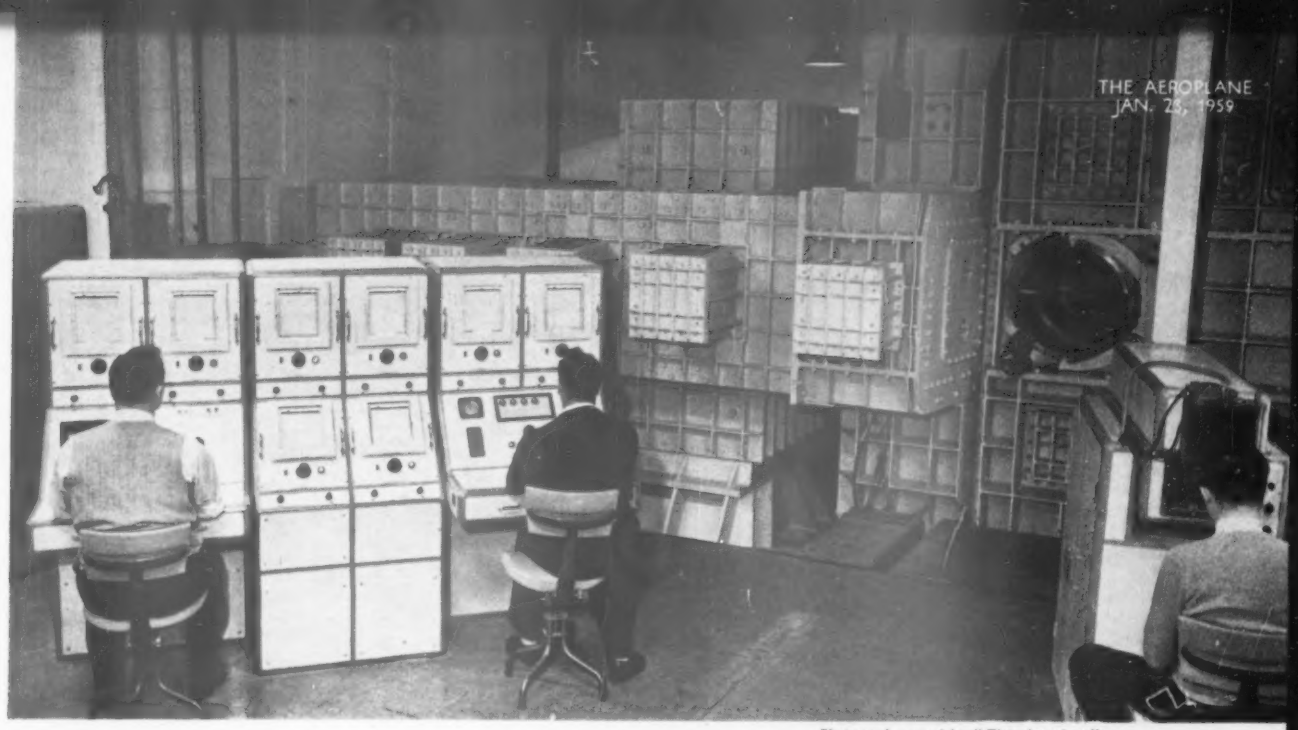
Men of Skill and Experience

EMANUEL TORELLI

Shell Fuelling Superintendent
at Kloten Airport,
Zurich, Switzerland

SHELL

ONE OF THE MEN RESPONSIBLE FOR SHELL WORLD-WIDE AVIATION SERVICE



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For Co-operative Research

The A.R.A.'s New Supersonic Wind-tunnel

AN important addition to the wind-tunnel facilities available to the aircraft industry in their co-operative research establishment on the outskirts of Bedford is now operational. This is the Aircraft Research Association's new supersonic (M=1.4 to 3.5) unit which has been constructed as an integral part of the original scheme for providing wind-tunnel facilities for the industry through a Mach number range from subsonic to just below hypersonic speeds. It has a working section 2¼ ft. high by 2¾ ft. wide. The following notes on the new tunnel have been prepared by the A.R.A. staff under Mr. R. Hills, the chief executive.

The axial compressor which drives it has 11 stages with a total power of 13,750 h.p. and is normally used as a suction plant on the Association's transonic tunnel to enable it to run above the speed of sound. The compressor circuit can, however, be isolated from the transonic tunnel by motorized valves and then run on a separate circuit for the supersonic tunnel.

Both these tunnels can be run at the same time provided the transonic one is not required for speeds above M=1. As in most model tests in the transonic tunnel, a considerable amount of work is done below M=1, there will be plenty of time available for running the compressor on the supersonic tunnel and the whole plant can be used to the best advantage. The changeover from one tunnel to the other by the motorized valves only takes a few minutes.

If a supersonic tunnel of constant working-section size is coupled directly to an axial compressor, the flow given by the compressor will not match that required by the tunnel over a range of Mach numbers. The working-section size must be chosen so that the compressor volume flow is sufficient to run it at the lowest Mach number required, and the compressor will then provide more volume flow than is necessary at the higher Mach numbers.

This characteristic can be utilized by providing an injector slot in the diffuser downstream of the working section and by passing the excess air from the compressor round the working section into this injector. In the new A.R.A. tunnel, where the working-section size is chosen to match the volume flow at M=1.4, the compressor gives an excess flow of about 120% of the flow required through the working section at M=3.5. This air is injected into the diffuser at a local Mach number of 1.7 and by its injector action considerably decreases the overall pressure drop between the entry to the working section and the exit from the diffuser.

Model tests made on a 4-in. square supersonic tunnel showed that with injection a pressure ratio of 3.6 was required for a Mach number of 3.4, compared with an estimated pressure ratio of about 5 without injection. As the pressure ratio on the compressor is limited to below about 4.2 because of surging, a speed of M=3.4 would not be obtainable without injection.

The new supersonic tunnel has, therefore, been designed for a Mach number range from 1.4 to 3.5, which the model tests showed can be achieved with the existing compressor. Model tests in the small tunnel could not be extended above M=3.4 and in the actual tunnel provision has been made for an extension of the Mach number to 4 if this proves possible.

Fig. 1 shows the tunnel circuit. The air from the compressor cooler passes through a 4-ft.-dia. motorized valve, which is one of the two isolating valves for the supersonic tunnel circuit. It then passes through a banjo-type junction, where the by-pass air is fed to the injector.

Just upstream of the contraction cone the tunnel section expands rapidly (50° total cone angle), using three spaced gauze screens which prevent separation in the wide-angle diffuser. A

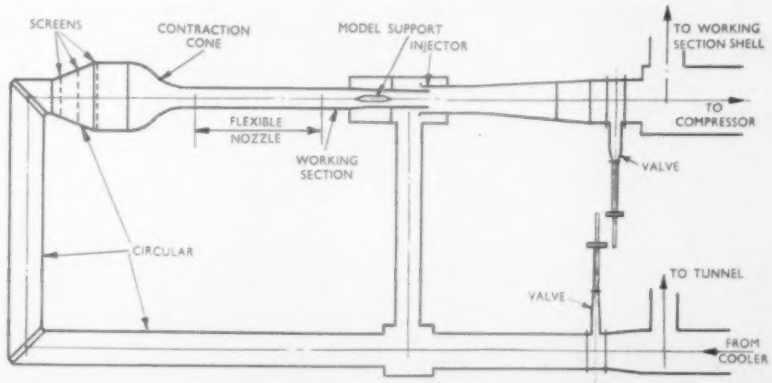


Fig. 1. The tunnel circuit.

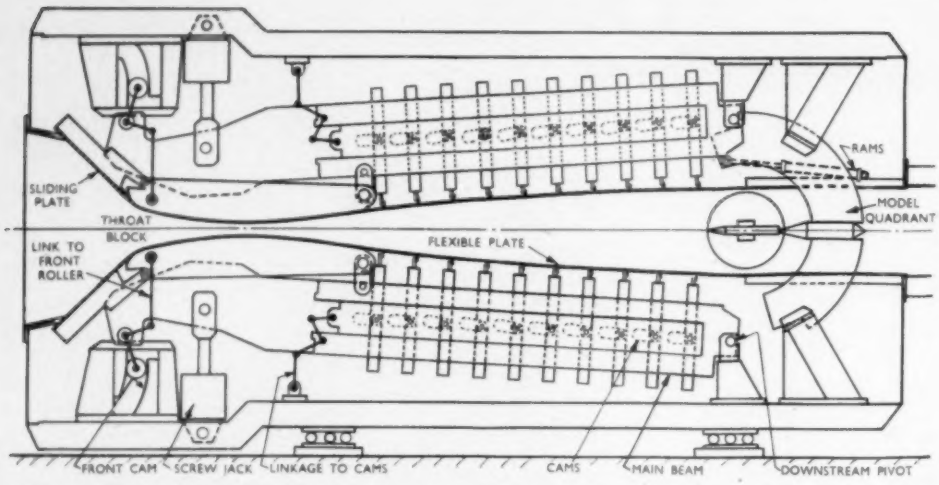


Fig. 2. The layout (simplified) of the operating mechanism for the flexible top and bottom walls of the A.R.A.'s supersonic wind-tunnel.

fixed contraction is followed by the nozzle section, which has flexible top and bottom walls with fixed parallel side walls.

These flexible walls are designed to give the exact nozzle shape for a Mach number range from 1.4 to 4, and they have been made so that they can be adjusted over this range when the tunnel is running. The principle is shown in Fig. 2.

The top and bottom flexible walls are supported from large beams running the whole length of this section and pivoted at their downstream ends. The upstream end of the flexible plate is permanently bent round a rigid former, which is held at its downstream end by a link on the beam and at its upstream end by a linkage to a roller moving in a cam. Downstream of this former, or throat block, the flexible plate is supported by a number of links whose vertical heights are fixed by rollers moving in cams mounted in horizontal slides on to the beam.

The upstream end of the beam can be moved up and down by a screw jack driven by a hydraulic motor. As it moves, a linkage system fixed to the tunnel structure causes the cams which adjust the flexible wall to move horizontally. By this means the heights of the links are altered relative to the beam and the shape of the flexible plate is changed. At the same time, movement of the roller in the front cam causes the former block to move to a new angle relative to the beam.

There is sufficient adjustment in this system to give the correct nozzle shapes for every Mach number in 0.1 steps over the range M = 1.4 to 4.

The sides of the flexible plate, which slide over the side walls, are sealed by polythene strips fitted in a groove in the sides of the plates and pressed against the side walls by a soft rubber backing strip. The chamber behind the flexible plate is vented to working-section pressure, so that the pressures across the plate are small: a fairly thin ($\frac{1}{4}$-in.) plate can, therefore, be used and the loads on the rollers and cams due to the bending of the plate and to air loads are, in consequence, small. This is the main reason why it was possible to use a design of this type instead of a more conventional one with individual screw jacks controlled by an expensive servo mechanism.

Mechanically the design has proved very satisfactory and control of the throat size can be obtained easily to less than ± 0.002 in., while the whole nozzle shape is within ± 0.005 in. of the theoretical for all Mach numbers. The movement over the whole range is obtained in $2\frac{1}{2}$ minutes.

From the limited calibration which has already been done the flow appears to be very uniform and the Mach number at the centre of the tunnel is within less than 0.01 of the design value. Some adjustment of nozzle shape could be made if required by altering link lengths, and if necessary new cams could be made, but it seems that this will not be required.

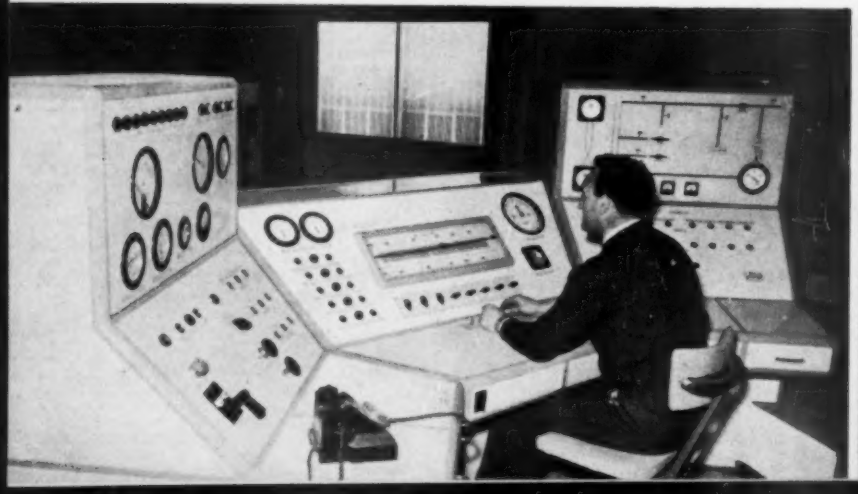
In the working section two 2-ft.-dia. windows with "Schlieren quality" glass enable flow photographs to be taken with a spark source and also allow continuous observation of Schlieren pictures and shadowgraph.

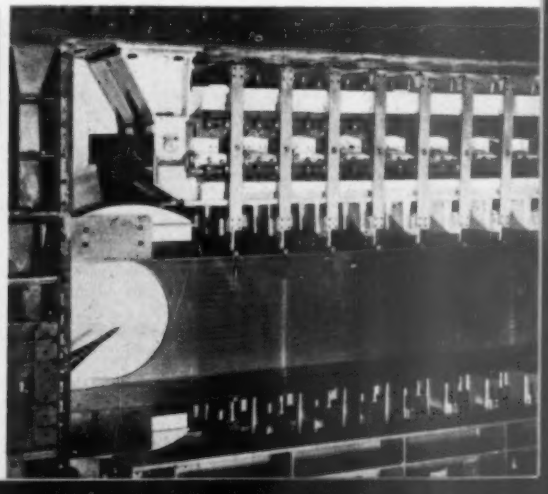
Support for the model consists of a quadrant and sting with the angle of incidence variation being obtained by hydraulic rams over a range from $-10°$ to $+45°$. The whole incidence

Photographs copyright "The Aeroplane"

Above, Mr. R. Hills (left) chief executive of the A.R.A. at the supersonic tunnel control panel.

Below, another view of the main control console; the central indicator panel shows the flexible wall configuration.





range can be traversed in 25 seconds and a stepping device is provided which automatically alters the incidence by a predetermined number of degrees each time a button is pressed. Roll over the range 0° to 360° is provided on the model by a rolling unit fitted between the sting and quadrant.

Downstream of the working section, the top and bottom walls of the diffuser are fixed and approximately parallel but, as indicated in Fig. 3, the side walls are divided into a number of hinged sections, each section being held in position by a hydraulic ram. These hydraulic rams can be adjusted while the tunnel is running to give the best possible diffuser configuration for any Mach number. The injector slot is fitted as part of this system and the amount of air injection can be changed by adjustment of the hydraulic rams to alter the slot width.

At the end of a further section of the fixed diffuser there is a 5-ft.-dia. valve, which is the other main isolating valve in the supersonic tunnel circuit. Downstream of this, the section expands to an 8-ft.-dia. collecting chamber immediately ahead of the compressor. In this section a metal honeycomb, backed by a gauze screen, has been built to provide a safeguard against any parts of a model flying into the compressor.

Photograph copyright "The Aeroplane"

This special frame is used for the calibration of the strain-gauge balances used in the supersonic tunnel.

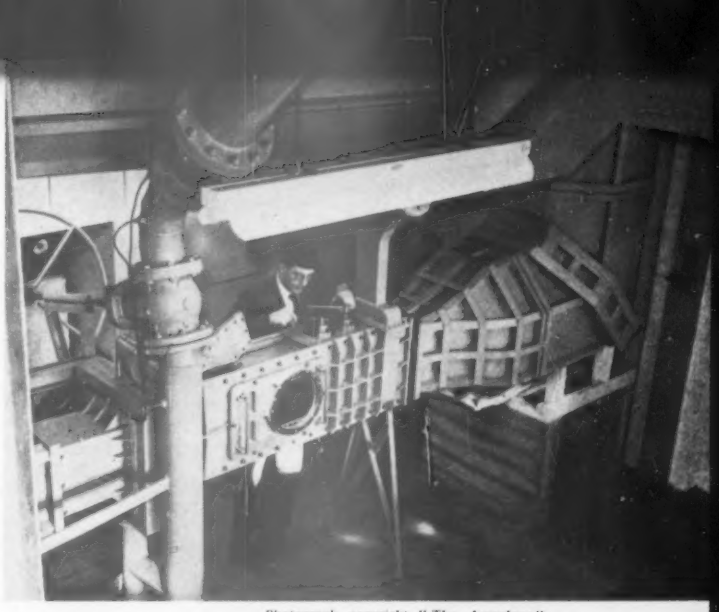
The tunnel can be run over a stagnation pressure range from ¼ to 1½ atmospheres and it is normally started at low pressure to avoid a large shock load on the model. Dry air is stored in a separate tank at 10 atmospheres pressure to raise the pressure in the tunnel circuit. This dry air is supplied by compressing air to 10 atmospheres, cooling, removing the water and then passing through a drier. Under running conditions sufficient air is bled into the tunnel circuit from the dry-air store to maintain dry air in it.

Measurements of the aerodynamic forces on models are made by strain-gauge balances mounted either inside the model or on the attachment sting. Signals from these strain gauges are fed to DC servo balancing potentiometers, which plot the resulting readings on a chart against incidence for visual inspection and feed a digitized voltage in binary form to a card punch.

Eight channels are normally provided, but these can be supplemented by further channels if required and up to a total of 20 quantities can be recorded on each card. These cards can then be fed directly into a computer, which corrects the results into the standard non-dimensional coefficient form.

A calibration frame is provided for calibrating the strain-gauge balances. This uses a series of levers with dead weights so that forces and moments can be applied in three directions while the electrical signals are fed to the same servo-balancing potentiometers and card-punch system to record the readings, which can then be worked out directly on the computer.

In order to ensure that the directions of the forces which are applied are accurately known, the balance is mounted in a rig with means of adjusting its level in the horizontal and vertical planes under different loads. The measurements of level are made by using standard workshop dial indicators reading to 0.001 in. Using this equipment, a balance measuring three components of force and three moments can be calibrated and all linear interactions measured in a few hours.



Photograph copyright "The Aeroplane"

This 1/12-scale model of the A.R.A. transonic tunnel has a working section 8 in. × 9 in. and is used for small-scale pilot experiments.

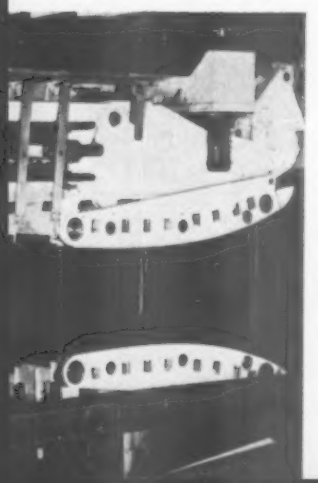
Pressure measurements can be made by photographic records of normal manometers or by using several Scanivalve pressure switches, which switch a number of pressure points to a single pressure transducer. This transducer records on a DC servo-balancing potentiometer, giving a chart record for visual observation, and also feeds the results on to a punched tape for transfer to the computer.

The A.R.A.'s transonic tunnel started model testing for the industry in February, 1957—though for one period of six months since then running was very limited due to a fatigue failure of the blades of the axial compressor. Some 35 tests on 18 different models have now been completed and the total fan running hours is over 1,300.

Tests made have included normal force measurements on both complete and partial models of aircraft, and missiles and more extensive pressure measurements on jet intakes, and on a propeller turbine intake with a cropped propeller being driven by a hydraulic oil motor inside the model.

Development of methods for testing flutter models is under way, together with the installation of sufficient air storage at high pressure to enable jet efflux effects to be reproduced.

A small transonic tunnel—one-twelfth of the size of the large one (i.e., having a working section 8 in. by 9 in.)—has been built to provide a means of doing small-scale pilot experiments on any rigs which might be required in the large tunnel. This uses an injector drive from a compressor air supply and will run for up to 2 minutes. It covers a Mach number range from subsonic to M=1.3. A simple flexible nozzle is provided, adjusted in this case by one screw jack, and the working section itself can either be fitted with two perforated walls with two glass windows on the other walls or with four perforated walls.



Left, a close-up of the top and bottom flexible walls and their cam mechanism.

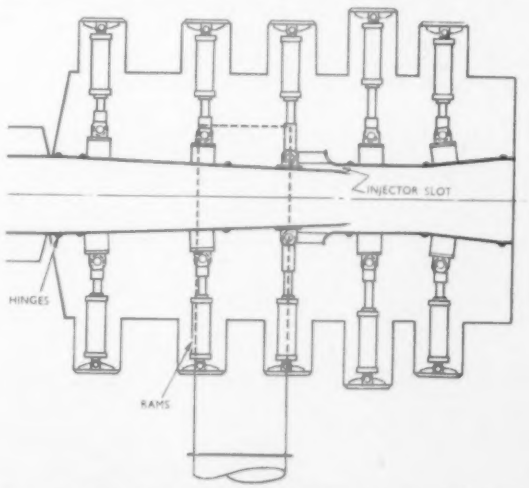


Fig. 3. The side walls of the diffuser have a number of hinged sections adjusted by hydraulic rams.

The Fighting Services

Maintenance Command Appointment

AIR VICE-MARSHAL J. D. BAKER-CARR, C.B., C.B.E., A.F.C., is to become Air Officer Commanding, No. 41 Group, Maintenance Command, with effect from May 1, 1959. Senior Technical Staff Officer at Headquarters, Fighter Command, since October, 1956, A.V.M. Baker-Carr previously commanded No. 4 School of Technical Training at R.A.F. St. Athan. Before taking the 1952 Imperial Defence College course he spent three years as Director of Air Armament Research Development at the Ministry of Supply.

"Victorious" Trials Completed

HAVING completed the work-up of the carrier's company, squadrons and equipment in the Mediterranean, H.M.S. "Victorious" (Capt. C. P. Coke, D.S.O., R.N.) returned to Portsmouth last week. In addition, the carrier has completed a series of trials on the D.H. Firestreak AAM with three specially equipped Sea Venoms of No. 893 Squadron (Lieut. Cdr. E. V. H. Manuel), the first operational Fleet Air Arm unit to test the air-to-air missiles.

In the trials, which were described in detail in THE AEROPLANE of November 28, 1958 (pp. 798-9), 80% of the missiles fired against Firefly U.9 drone aircraft of No. 728 Squadron (Lieut. Cdr. J. Corbett) were completely successful and the remainder were very near misses. These firings have proved the carrier's Firestreak system from packaged weapons, through the various stages of supply, testing and handling, thus preparing the way for Firestreak-equipped Sea Vixens on their introduction into squadron service later this year.

Following a period of leave for the crew, "Victorious" will re-embark her squadrons and return to the Mediterranean to take part in a NATO exercise.

The R.N.Z.A.F. in Malaya

IN December of last year No. 41 (Transport) Squadron (Sqn. Ldr. G. H. S. Tosland), R.N.Z.A.F., logged its two-millionth mile flown over Malaya as one of its Bristol Freighters parachuted Christmas dinner to security forces in the jungle. Another milestone in the squadron's history—the carrying of 50 million pounds of freight—was also passed just before the end of 1958.

Stationed at R.A.F. Changi, the squadron forms part of the F.E.A.F. Transport Wing, and is engaged on regular route flying, supply dropping and general transport work. Together with No. 75 (Bomber) Squadron, based at R.A.F. Tengah with Canberras, it forms the present New Zealand air contribution to the Commonwealth Strategic Reserve in south-east Asia.

No. 41 Squadron claims the highest serviceability rate for its aircraft in the Command, and has always met its monthly flying commitments. It has "tramped" all over the Far East since it arrived in Malaya in May, 1955, visiting Hong Kong, Vietnam, Laos, Thailand, Burma, Ceylon, the Maldives, New Guinea, Papua, North Borneo, Car Nicobar, Christmas Island, the Cocos-Keeling Islands, Goa, India, Nepal, Japan, Korea, Okinawa, Cambodia and Pakistan. To date, No. 41 Squadron Freighters attached to the F.E.A.F. have dropped more than 1,750,000 lb. of supplies and ammunition.

Last August the squadron set a new record by dropping just over 210,000 lb. of supplies in 32 sorties. But this new record was soon eclipsed; during October two aircraft operating from the Air Supply Headquarters based at Kuala Lumpur dropped 226,000 lb. in 35 sorties.

Central Reconnaissance Establishment

GROUP CAPTAIN E. G. JONES, C.B.E., D.S.O., D.F.C., officer commanding R.A.F. Wyton, since January, 1957, has become Commandant of the Central Reconnaissance Establishment at R.A.F. Brampton, with the acting rank of Air Cdre. Posted to Headquarters, 2nd T.A.F., for operations duties in October, 1953, he attended the 1956 Imperial Defence College course. Later that year Gp. Capt. Jones was attached to Headquarters, Air Task Force, as Group Captain in charge of Operations during the Suez campaign.

Award for an Essay

THE Brooke-Popham Memorial Trophy, commemorating the late Air Chief Marshal Sir Robert Brooke-Popham, has been won for 1958 by Sqn. Ldr. J. A. Davies, D.F.C., B.A., of the R.A.F. Education Branch, who has recently taken up duties at Headquarters, Allied Air Forces Central Europe. The trophy is awarded annually for competition by officers taking the course at the R.A.F. Staff College, Bracknell, and goes to the officer submitting the best essay on a selected subject of typical Service interest.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Group Captain H. E. C. Boxer, O.B.E., A.D.C., to the Imperial Defence College for studies.

Wing Commanders: E. T. McCabe, O.B.E., to No. 4 School of Technical Training as Senior Technical Officer (with acting rank of Gp. Capt.); H. W. G. Andrews, D.F.C., to SHAPE; R. G. R. Buckley to Headquarters, Fighter Command, for technical staff duties; W. J. F. Fenton to R.A.F. St. Athan for administrative duties; G. Goodman, M.B.E., D.F.C., to Headquarters, M.E.A.F., for technical staff duties; K. G. Hubbard, O.B.E., D.F.C., A.F.C., to Headquarters, Bomber Command, for plans and policy duties; R. Jones to M.o.S.; J. H. King to Headquarters, Flying Training Command, for administrative staff duties; H. T. Morgan to R.A.F. St. Athan for administrative duties; J. Northrop, D.S.O., D.F.C., A.F.C., to Headquarters, 2nd T.A.F., as President of the Standing Court-Martial; P. Raby to the 2nd A.T.A.F. for staff duties; J. Sanderson to A.A.F.C.E. for staff duties; A. B. Thomas to Air Ministry for duties in the Department of the Air Member for Supply and Organization.

Squadron Leaders: G. F. Banyard to R.A.F. Hullavington as Chief Instructor, Air Electronics (with acting rank of Wg. Cdr.); I. D. Bolton, D.F.C., to the R.A.F. Staff College, Bracknell, for Directing Staff duties (with acting rank of Wg. Cdr.); J. J. Deverill to Headquarters, British Forces Aden Peninsular (with acting rank of Wg. Cdr.); M. Driscoll to R.A.F. Kirton-in-Lindsey to command (with acting rank of Wg. Cdr.); V. R. L. Evans to R.A.F. Boscombe Down to command "A" Squadron (with acting rank of Wg. Cdr.); F. A. Hall, M.C., to Headquarters, 2nd A.T.A.F., for air staff duties (with acting rank of Wg. Cdr.); K. W. Haynes to SHAPE for staff duties (with acting rank of Wg. Cdr.).

FLIGHT TESTING.—The first Britannia 253 for Transport Command is seen here at Short Brothers and Harland's airfield, at Belfast, where it is undergoing its flight-test programme. Making its first flight on December 29, the aircraft is one of 15 being built at Belfast for the Service, the remaining five 253s on order will be assembled at Bristol.

Jet Provost

The standard primary/basic trainer for the Royal Air Force

An intensive and thorough evaluation carried out with Mk.1 aircraft has paved the way to the current production version, the Mk.3. Refinements include hydraulically operated services, Martin-Baker ejection seats, wing-tip auxiliary fuel tanks and a one-piece moulded windscreen.

All Jet Provosts are powered by the Armstrong Siddeley Viper turbojet.

"The Aeroplane" photo

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Commander V. Cus	Italian Air Force
J. Bryce	Vickers-Armstrongs (Aircraft) Ltd.
A. E. Gunn	Boulton Paul Aircraft Ltd.
P. M. R. Walton	Sir W. G. Armstrong Whitworth Aircraft Ltd.
J. Zurakowski	Avro Aircraft Ltd. (Canada)
M. C. Muir	De Havilland Aircraft Co. Ltd.
G. J. Horne	Vickers-Armstrongs (Aircraft) Ltd.
J. Haflinger	F.F.A.G. Switzerland
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Comet Operating Experience

To the many airlines at this time considering the operation of turbojet transports, R.A.F. Transport Command offers the fruits of 2½ years' experience with the Comet 2. This article is based on an official "progress report" due to appear in the February issue of the DE HAVILLAND GAZETTE.

FLYING with No. 216 Squadron, at Lyneham, the 10 Rolls-Royce Avon-engined Comet 2s have flown some 16,000 hours, and offered approximately 300 million passenger miles. They have operated on a World-wide basis in temperatures ranging from the Arctic cold of Iceland or Labrador to the wet heat of Burma or Singapore, and over distances from as short as 200 miles (London to Paris) up to a flight of 30,000 miles round the World such as was recently completed by Air Marshal Sir Andrew McKee, A.O.C.-in-C., R.A.F. Transport Command, and Inspector of Air Transport Services.

Sir Andrew stated recently that, although there obviously had been a number of problems, the fact that most of these had been overcome with, if anything, less difficulty than would have been expected when introducing a conventional type of transport aircraft, says much for the basic design of the aircraft, the accurate performance data and the operating techniques evolved by the manufacturers and B.O.A.C.

The Comet had proved to be exceptionally reliable, and when it had been necessary to operate at high intensity, minor unserviceabilities could be carried without seriously affecting operational efficiency. The build-up of experience by flying and servicing personnel had naturally contributed to the high serviceability that it had been possible to achieve. Experience had shown that the Comet can be relied upon to operate successfully away from its main base with little support.

A survey of Comet 2 operations covering flights made to almost every part of the world over these 2½ years shows that there have been few ground handling problems, the main requirement being for hard-standings adequate to take the weight of the aircraft. In practice, however, even Pierced Steel Plate (PSP) has proved acceptable as a temporary measure provided sharp turns when taxying are avoided and use of this kind of surface is not continuous. Jet blast has not caused any serious damage to surfaces and there have been no reports of sand, stones or debris being picked up by the engines.

There have been no complaints of excessive noise, and no runway difficulties have been encountered anywhere.

In-flight Handling

Approximately 300 operational GCA approaches have been made at R.A.F. Lyneham, more than 60 of these with a cloud base less than 400 ft. From the control aspect the Comet handles well on final talk-down.

On the eastabout route from the U.K. to Singapore and Australia no difficulty has been experienced in obtaining clearance for a cruise-climb, and a slow let-down from about 180 nautical miles. It has been found that when Eureka Mk. 7 beacons or other fixing and ranging facilities are available the slow let-down is the more economical. Lateral separation of tracks on the main trunk route has been adopted with the agreement of Air Ministry.

Clearance to cruise-climb is rarely obtained on the westabout route across Canada and North America and level cruises have had to be used. The 4,000-ft. step between each successive quadrantal height means that the aircraft is sometimes 3,000 ft. from the optimum cruise-climb height for A.U.W. and temperature. Although the Comet can accept these conditions, vertical separation is not an ideal method of en-route separation for jet-transport aircraft.

Little difficulty has been found in complying with air-traffic requirements, including climbing and letting down through airways using the current LF/MF beacons and ranges, and marker beacons. In the United States, however, the lack of means of positive indentification in flight (until recently), and of VOR beacons, has been a handicap, and it has often been found best to arrive overhead at 20,000 ft. and then let down at a high rate of descent.

The fact that little difficulty has been experienced in complying with air-traffic requirements has been due not only to the Comet's ability to fit into today's air-traffic control arrangements, but in large measure to the fact that no other jet-transport aircraft has been in operation over the routes flown.

Navigation Aids

There is a need for an independent fixing aid on long sea legs in daylight, or at night when astro is not possible, but otherwise the navigation equipment has been found to be satisfactory on the eastabout route. LORAN performance on the westabout route has been disappointing but there is some gradual improvement. Individually, the performance of the various aids has been as follows:—

(a) *Twin Marconi ADF (ARI 7092).* Excellent results.

(b) *DME (Mk. 6A).* Ranges in excess of 170 n.m. have been fairly consistent both inbound and outbound using the Eureka Mk. 7 beacon. The results have been less reliable using Eureka Mks. 2 and 4 beacons, since the frequency of the ground beacon is less stable and the Comet navigator cannot frequency-sweep.

(c) *ILS.* As well as being used for its primary purpose, this aid has been used navigationally in Australia with the VAR system.

(d) *Gee (Mk. 3).* Excellent where coverage is available.

(e) *LORAN (APN 9).* Disappointing results. Gradual improvement.

(f) *Periscopic Sextant (Mk. 1).* This has been giving consistently excellent results.

(g) *Ekco 120 Cloud Collision Warning Radar.* An excellent navigational aid.

Contrary to airline practice it is the navigator's responsibility on R.A.F. Comets to compile the flight plan for each succeeding leg; this takes the form of a combined navigation and fuel plan. A special form was designed for use with the Comet and this includes a "Howgozit" on the back (see THE AEROPLANE, May 17, 1957).

The "Howgozit" uses the argument of fuel against distance, and both the critical point and point of no return are plotted graphically on it. Initially, the flight plan was prepared using the graphs in the Crews Notes, but this method has now been simplified by the use of a specially designed slide-rule and the introduction of tabular presentation.

Minimum sector fuel-loads have been calculated for each stage-length for each season and these are mandatory. Captains, however, may add to the calculated loads whenever forecast winds are more adverse than those used in the calculation.

At first the computation of minimum sector-fuel was based

In the course of regular duties with the R.A.F., Comets of No. 216 Squadron have operated all over the World. This one was visiting Moscow in July, 1956.

on the maximum headwind component experienced on 50% of occasions but, as a result of an analysis of the actual fuel used, the frequency-head wind has been reduced to 30% and, for payload planning—originally based on the 85% headwind between departure and destination airfields—the 70% frequency-headwind is now used. This factor, together with continuous analysis, ensures that fuel loads are adequate but not excessive. The increase in permissible take-off weight to 122,000 lb. permits full passenger load to be carried on practically all legs.

An interesting factor affecting fuel reserves on critical legs flown from tropical airfields has been the reduction in weight of fuel which can be put into the tanks owing to the low specific gravity of the fuel. These losses have accounted for up to 3,000 lb. of fuel.

Cruise Control

A cruise-climb at 1.2 VMD has been adopted, with half-hourly adjustments of r.p.m. and R.A.S. (rectified air speed) to allow for changes in A.U.W. and temperature. This has involved an initial cruising altitude of between 35,000 and 38,000 ft. and a drift up to about 39,000 to 42,000 ft. at the rate of about 1,500 ft. per hour. In the tropics much of the cruise is therefore below the tropopause, so R.A.S. rather than Mach number is used as the datum. The average Mach number resulting from the R.A.S. is 0.73, giving a T.A.S. of about 420 knots (484 m.p.h.).

A half-hour fixing cycle is maintained using ADF when possible and, elsewhere, astro supplemented by any other aids available. The "most probable position" technique is used for long sea legs on which only sun position lines are available, but this tends to lead to slow appreciation of errors in forecast winds, particularly on westabout legs when the sun's azimuth changes very little. Some independent aid would enable critical legs to be flown in the face of strong adverse wind forecasts, besides being essential in conditions where air-traffic regulations require accurate track-keeping. Errors of 60 n.m. in position can occur when unforeseen jet streams are encountered.

A manual air plot is maintained using T.A.S. derived from Mach number and temperature measurements taken at the quarter and three-quarter hour. Wind velocities are found every half an hour.

The fixing cycle has been extended to one fix every 40 minutes for legs over which astro is the sole aid, so as to allow time for continuous pre-computation of sights and sextant manipulation. Limited use of two different types of astrograph has given encouraging results.

The experience gained from R.A.F. Transport Command's military jet "airliner" operations has been instrumental in obtaining a steady improvement in the accuracy with which high-level winds have been forecast. An analysis has now been made of all winds found in the air and these have been compared with the statistical mean and those forecast. Jet streams have been experienced practically everywhere and they have not necessarily been accompanied by clear-air turbulence. Operations have emphasized the importance of passing terminal and diversion forecasts rapidly to jet aircraft.

Experience of conditions in the Inter-Tropical Front regions has shown that at heights of between 36,000 and 43,000 ft. serviceable cloud-collision warning radar is essential as it has not been found possible accurately to forecast whether severe turbulence will be experienced.

Comet Aircrew and the Duty Day

Whilst the average day's flying for the crews of a conventional four-piston-engined transport is seven to eight hours, that of the Comet crew is longer, consisting generally of two four-hour legs divided by a flag stop of 1½ to two hours, during which time no relaxation is possible. The many advantages, however—greatly reduced noise levels, lack of vibration, better comfort, and in-flight amenities (flushing toilets, hot and cold running water, electric razors, etc.)—reduce the importance of the fatigue factor. Comet crew morale is high.

The basic requirement for selection of crew members was that they should hold, or have held, at least a "B" Transport Command category. Captains were to have a minimum of 1,500 hours' first-pilot experience, of which 400 hours were to be on four-engined aircraft. The average age and experience of the crews actually selected and trained were as follows:—

(a) Captains.—Thirty-five years of age with 3,800 hours' first-pilot time.

(b) Navigators.—Thirty-two years of age with 2,600 hours' experience.

(c) Signallers.—Thirty-three years of age with 3,000 hours' experience.

(d) Engineers.—Thirty years of age with 2,600 hours' experience.

To save the expense of a ground school at Lyneham all ground instruction on the aircraft was done at the manufacturers. The durations of the courses were:—

(a) All pilots.—Four weeks at de Havilland and one week at Rolls-Royce.

(b) Navigators and Signallers.—Two weeks at de Havilland and one week at Marconi.

(c) Engineers.—Eleven weeks at de Havilland and one week at Rolls-Royce.

It was intended that all captains and co-pilots should be given a jet-conversion course on Meteors at R.A.F. Manby, followed by a short course at the Canberra Operational Conversion Unit for the navigator's benefit. All captains completed the Manby course, but, for administrative reasons, it was possible for only six to complete the Canberra course. In the event, the loss of the latter course did not materially affect the progress of those captains who did not take it. The Meteor course was, however, considered essential.

A Comet conversion course of 55 hours' day flying and 20 hours' night flying was arranged, to bring pilots to passenger-carrying standards. This was broken down into:—

(a) Eighteen hours' dual, including categorization tests and instrument rating.

(b) Seventeen hours' solo flying.

(c) Forty hours' screened route flying.

Experience showed the course to be both necessary and satisfactory. Before being granted a Transport Command Passenger Carrying "C" category certificate, all captains had completed 75 hours' dual and solo.

B.O.A.C.'s experience with the Comet 1 simulator—which was modified for use by Transport Command—was used to evolve the following syllabus for all R.A.F. Comet pilots (24 are established on No. 216 Squadron at any one time):—

(a) Initial course.—Fifteen hours.

(b) Advanced course.—Nine hours.

(c) Continuation Training:—Captains, four hours per month. (This is raised to six hours per month when their route flying and air continuation training is low.)

Comets are frequently used in the aero-medical rôle, carrying sick or wounded servicemen back to the U.K. in comfort.

Blind Landing Progress

FOR some time now the Blind Landing Experimental Unit (B.L.E.U.) of R.A.E. Bedford has been actively engaged on research and development into various methods of making a completely blind landing; on January 16 the superintendent of the Unit, Mr. W. J. Charnley, presented a paper entitled "Blind Landing" to the Institute of Navigation.

This lecture dealt with the single-channel automatic blind-landing system developed by B.L.E.U., considered the application of the system to civil aviation, and presented some thoughts on a pilot's independent pictorial monitor for such landings.

The automatic landing system outlined in the paper was described in THE AEROPLANE of October 17, 1958, and only a brief description is given on this page. This is followed by some of the problems involved in its civil application and notes on the B.L.E.U. pictorial monitor, known at the Televiewer.

In an advanced stage of development, the B.L.E.U. landing system consists of landing the aircraft automatically by coupling it through an automatic pilot in the aircraft to a radio guidance system, the pilot performing the important task of monitoring the behaviour of the automatic equipment.

The landing starts with an automatic approach in which signals from an Instrument Landing System (ILS) are fed to the automatic pilot to lock the aircraft on the approach beam. During the last mile of the approach two new and more accurate guidance elements — magnetic leader cable in the horizontal plane and radio altimeter in the vertical plane — are introduced. Just before touchdown any drift due to crosswind is removed so that the aircraft lands accurately aligned with the runway.

After touchdown the pilot disengages the automatic pilot and steers the aircraft to a stop using signals from the magnetic leader cable displayed on his flight instruments. A final feature is the inclusion of automatic speed control in which the engine throttles are moved automatically to maintain a constant speed during the approach and then throttled back to reduce the speed during the landing.

Should future developments improve the ILS approach guidance to such an extent that it can be used for landing guidance as well, the system can be easily adapted, but in its present form it employs the following items of equipment:—

The ILS for azimuth and glide-path approach guidance; magnetic leader cable for azimuth landing guidance; radio altimeter for vertical landing guidance; automatic pilot for automatic coupling to the radio guidance element; automatic speed control, and flight director instrument display for the presentation of pilot monitoring information.

From a functional point of view the aircraft on an ILS approach enters the coverage of the leader cable system at an altitude of about 300 ft., when a signal from the leader cable gain-control primes the sequence-switching circuit and changes the azimuth control from ILS localizer to leader cable. At approximately 100 ft. the ILS glide-path signal into the automatic pilot is disconnected and the aircraft is controlled to a pitch attitude datum established while the aircraft was flown down the glide path.

This continues down to a height of about 60 ft. when the flare-out, computed from the radio-altimeter height information begins. Also at about 60 ft. the throttles are slowly closed to the safe flight-idling position. At approximately 20 ft. the leader cable azimuth control is disconnected, the wings levelled and rudder applied to yaw the aircraft round towards the pre-set heading of the runway so as to reduce the drift angle at touchdown.

More than 2,000 safe and successful automatic landings have been made in all weathers, including fog, and a wide range of wind conditions have been explored varying from 25-knot headwind to 10-knot tailwind and up to a 15-knot cross-wind component. The table shows the results of a statistical analysis of a representative sample of automatic landings.

Touchdown parameter	Mean	R.M.S.
Lateral Displacement from runway centreline (ft.) ..	10	10
Lateral tracking velocity(ft./sec.)	1.0	1.5
Rate of descent (ft./sec.) ..	2.0	1.2
Longitudinal displacement along runway from origin of ILS glide path (yd.)	150	65

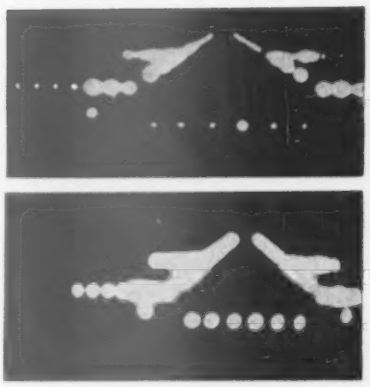
Problems in Civil Application

The present civil accident rate from all causes is about 2 in 10^6 flying hours, and it seems reasonable to suggest, that to maintain this figure from all causes the reliability of any particular system should be an order of magnitude higher. On this argument, an automatic landing equipment should have a failure rate of not worse than 1 in 10^7 flying hours.

With a reliability of this order the extra landing safety obtained from the use of the system can produce a significant improvement in the overall accident rate since statistics show that about 30% of the total accidents occur during approach and landing.

At one extreme is the suggestion that only a single-channel equipment is necessary. As the landing phase lasts for only about 2 min. and as each piece of airborne equipment can be tested for correct operation before it is switched automatically into the system, it is argued that by careful design and monitoring a single channel will give the reliability required. In the opinion of the lecturer it is unlikely that any certificating authority will accept any type of single-channel system for civil use.

Another argument demands multiple channels of the same equipment so arranged that if one channel fails another takes over automatically and completes the landing without any change of flight path. This school of thought maintains that the chances of any pilot preventing disaster following certain malfunctions at a low height, say 50 to 60 ft., would be very small indeed and consequently they do not admit that the pilot can play any part in the automatic landing operation (even in an emergency) until after touchdown. Opinion on the number of channels required varies between two and four.



Two typical cathode-ray tube displays of runway lighting from the television experiment. Aircraft with an approach speed of 135 knots have been landed using this system.

Yet a third argument again favours multiple channels but demands that the channels be independent, i.e., an automatic landing system should be backed up by a completely independent pictorial monitor so that the pilot has at all times the "feel" of the landing, and so that in the event of a failure of the automatic system he can take over immediately and make a normal manual landing from the picture.

A variation of this argument is that such an independent monitor would be very useful during the introductory period of automatic landing (say for five years) until user confidence in the automatic system had been built up. One possible system for producing the independent picture is the Televiewer discussed in the next paragraph.

Pictorial Monitor

Flight experiments have been conducted by B.L.E.U. using a closed-circuit television system installed first in a Devon and later in a Meteor. The television camera is mounted on the nose of the aircraft and the monitor tube is viewed by the pilot. The experiments, made both by day and night, have shown that a pilot can land an aircraft satisfactorily with an approach speed of 135 knots using a picture of runway lights presented to him on a cathode-ray tube.

The concept of the Televiewer therefore consists of a number of radio beacons placed in some suitable pattern about the runway, and the aircraft carries a receiver capable of direction-finding on each beacon, thereby generating in the aircraft a picture of these beacons on a cathode-ray tube. The position of the beacons is measured relative to the aircraft axis, thus giving a picture similar to that seen by the eye through the cockpit windscreen. None of the aircraft's normal flight instruments is used in generating it. As neither visible light nor infra-red will penetrate fog (as distinct from haze) a radio frequency must be used.

There are many possible types of systems, but the number has been narrowed down by theoretical work at B.L.E.U. Experimental work has begun on the more promising ones, but it will be a year or two before it is known if any of them has an acceptable performance combined with promise of engineering into an acceptable system.

Solar-System Reconnaissance

By S. W. Greenwood, B.Sc., M.Eng., A.M.I.Mech.E., A.F.R.Ae.S.*

THE exploration of the Solar System will be a long and exciting venture. In the earlier stages it is apparent that a considerable amount of new knowledge can be obtained by launching vehicles into space on long journeys which range both outward from the Sun and inward towards it, without in the first instance facing the problem of entering orbits around other planets or their moons.

Such vehicles will become artificial satellites of the Sun, or artificial planets, during their flight through space, and will supply extensive information on conditions in space and in the regions of other bodies which may be closely approached during the journey.

The most desirable orbits to follow appear to be those which will carry a given vehicle the greatest possible distance. Such orbits are elliptic in shape and touch the Earth's orbit at the launching point. The elliptic orbits under consideration fall into two main categories as shown in Fig. 1. Those lying outside the Earth's orbit take more than one year to trace out once, while those lying inside the Earth's orbit take less than one year.

An infinite number of orbits are possible in each category, but attention is here concentrated on those which give favourable path times permitting recovery at the Earth if desired in a reasonably short period consisting of a whole number of years.

In the case of journeys outside the Earth's orbit most desirable from the viewpoint of total journey time are those in which a single elliptic path is traced out in a whole number of years; points on Fig. 2 are plotted on this basis.

In the case of journeys inside the Earth's orbit the most desirable from the viewpoint of total journey time are those in which the elliptic path is traced out a number of times that exceeds by one the number of revolutions of the Sun made by the Earth; points on Fig. 3 are plotted on this basis.

Points on Figs. 2 and 3 which lie between the plotted points correspond to journeys that are less favourable from the viewpoint of total journey time when recovery is intended. However, there may be cases where recovery is not intended, or where the limiting factor is the available vehicle performance, when orbits other than those represented by the plotted points will be considered acceptable.

It is customary to represent the required performance level of a space vehicle by means of a velocity requirement. This is the velocity that could theoretically be reached in a single operation in the absence of gravity and in a vacuum by a vehicle capable of carrying out the required operations. The velocity requirement for entry into an elliptic orbit of the type under discussion is plotted in Figs. 2 and 3 for two cases.

The lower curves are for departure from a circular orbit around the Earth and are taken from a previous note by the author ("Reconnaissance Orbits," *Journal of the British Interplanetary Society*, September-October, 1958). The upper curves are for departure from rest on the Earth's surface.

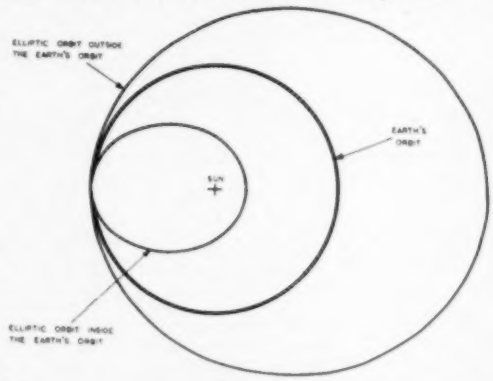
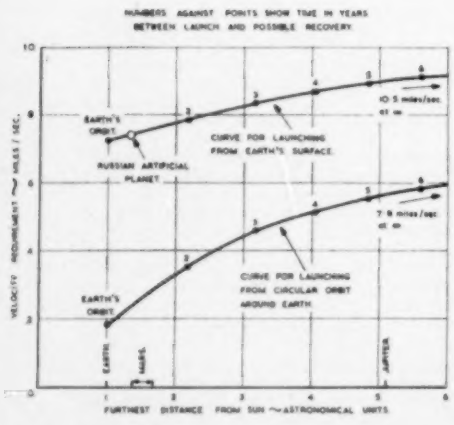


Fig. 1. Right, types of elliptic orbit.

Fig. 2. Below, results for elliptic orbits outside the Earth's orbit.


NUMBERS AGAINST POINTS SHOW TIME IN YEARS BETWEEN LAUNCH AND POSSIBLE RECOVERY
VELOCITY REQUIREMENT ~ MILES / SEC.
EARTH'S ORBIT
RUSSIAN ARTIFICIAL PLANET
CURVE FOR LAUNCHING FROM EARTH'S SURFACE
10·5 miles/sec at ∞
7·9 miles/sec at ∞
CURVE FOR LAUNCHING FROM CIRCULAR ORBIT AROUND EARTH
EARTH
MARS
JUPITER
FURTHEST DISTANCE FROM SUN ~ ASTRONOMICAL UNITS

The former data are of interest in connection with proposals for orbital techniques in which it is envisaged that Earth satellites will be used as launching stages for space vehicles, and the latter apply to the possibilities opened up by the successful launching by the Russians from the Earth's surface of an artificial planet on January 2.

If the vehicle is to be recovered, the velocity requirement will be greater than that shown. In the case of the lower curves the requirement is doubled if the vehicle is required to re-enter the circular orbit around the Earth.

In the case of the upper curves, the value of the requirement for the corresponding point on the lower curve is added to that for the upper curve if recovery is to take place through re-entry to a circular orbit around the Earth; if a return to the Earth's surface is required, the amount to be added is at present uncertain in that it is not yet established to what extent the approach velocity must be reduced by rocket braking before atmospheric drag techniques are employed to reduce the velocity without the application of power.

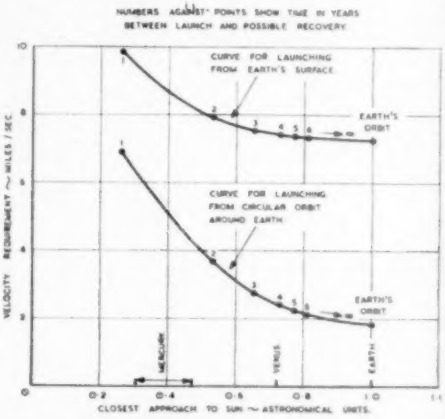

NUMBERS AGAINST POINTS SHOW TIME IN YEARS BETWEEN LAUNCH AND POSSIBLE RECOVERY
VELOCITY REQUIREMENT ~ MILES / SEC.
CURVE FOR LAUNCHING FROM EARTH'S SURFACE
EARTH'S ORBIT
CURVE FOR LAUNCHING FROM CIRCULAR ORBIT AROUND EARTH
EARTH'S ORBIT
MERCURY
VENUS
EARTH
CLOSEST APPROACH TO SUN ~ ASTRONOMICAL UNITS

Fig. 3. Results for elliptic orbits inside the Earth's orbit.

Examination of Figs. 2 and 3 will reveal the considerable scope for exploration possible with vehicles having a performance substantially the same as that of the rocket vehicle which launched the Russian artificial planet. The vehicle's performance is indicated approximately on Fig. 2 and shows that a velocity requirement of about 7.4 miles/sec. was met. An increase to 7.9 miles/sec. would permit the establishment of an orbit which carried the vehicle well beyond the orbit of Mars, and which would return to the vicinity of the Earth after a period of two years.

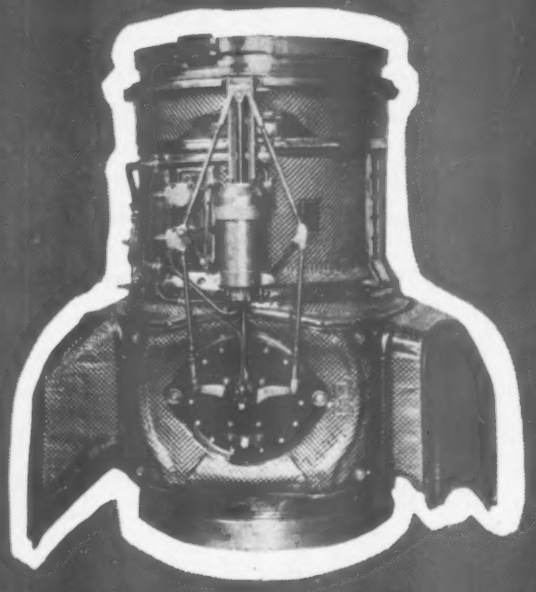
The figure of 7.4 miles/sec. attained by the Russian vehicle, if employed on a journey inside the Earth's orbit, could be used to send a vehicle as far as the orbit of Venus, and return to the vicinity of the Earth after four years.

In the limit, a velocity requirement of 10.5 miles/sec. is enough to permit an Earth-surface-launched vehicle to escape completely from the Solar System, or to journey inward close to the Sun and well within the orbit of Mercury. With present-day techniques it should be possible to accomplish these missions through the addition of a single rocket stage to the type of multi-stage rocket presumably used in the recent Russian launching.

In this note attention has been confined to possible orbits and the associated vehicle performance requirements. Problems of guiding and controlling these vehicles are certainly severe. We may, however, expect that before attempting direct exploration of other

(*Continued on page 105*)

* Lecturer, Department of Aircraft Propulsion, The College of Aeronautics, Cranfield.



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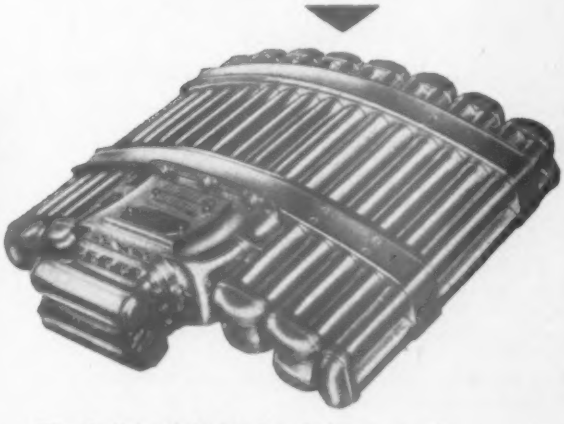

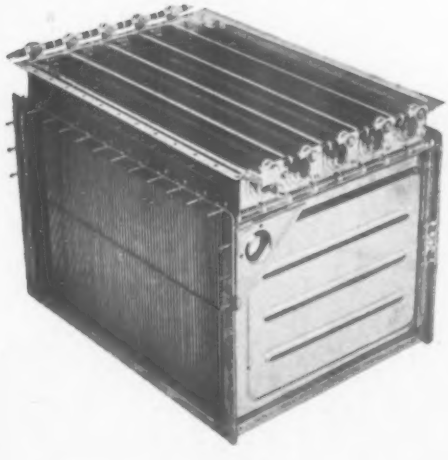

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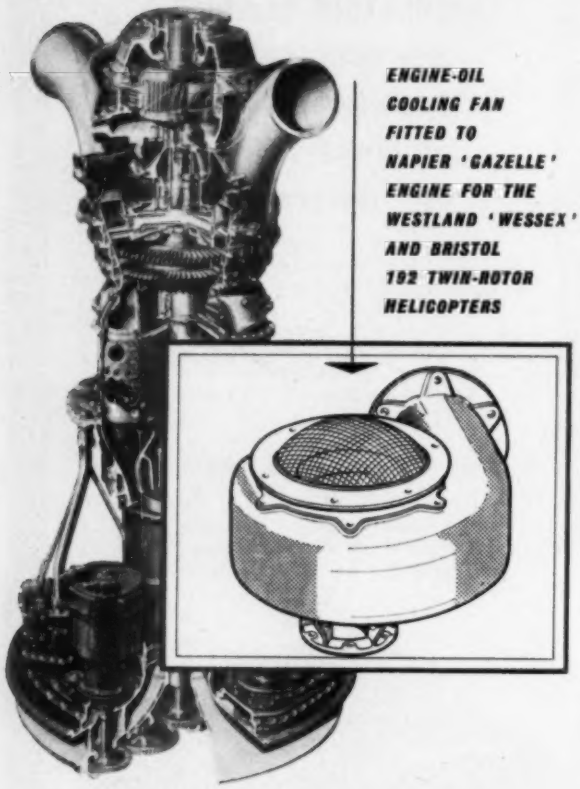

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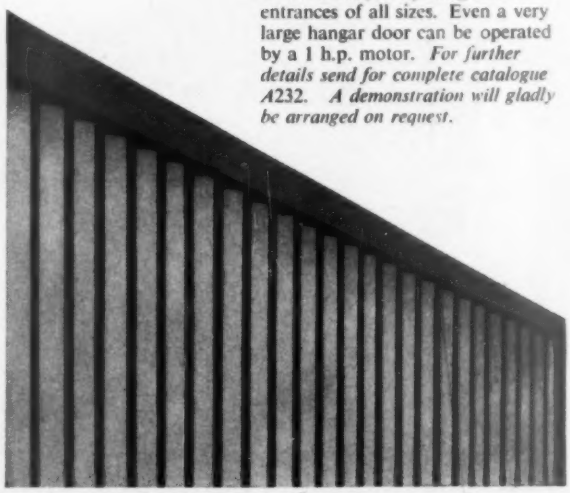

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(*Continued from page 104*)

worlds, extensive use will be made of techniques of Solar - System Reconnaissance.

APPENDIX

Assumptions and Outline of Method of Calculation

1. The processes of vehicle launching and recovery take place over distances that are negligibly short compared with the lengths of the orbital paths.

The elliptic orbits are assumed to be co-planar with the orbit of the Earth, which is taken as circular. Time (t in years) to trace out one ellipse in an elliptic orbit around the Sun $= a^{3/2}$ where a = semi-major axis in A.U.

$$= \frac{D+1}{2}$$ for reconnaissance from Earth

D being the distance (in A.U.) of perihelion (for $D < 1$) or aphelion (for $D > 1$) from the Sun.

Thus $D = 2t^{2/3} - 1$.

2. Velocity requirement for transfer from circular orbit around Earth to elliptic orbit around Sun is:

$$V = \sqrt{(x^2 + y^2)}$$

where

x = velocity requirement to reach Earth escape velocity from circular orbit around Earth,

y = velocity requirement to reach aphelion velocity ($D < 1$) or perihelion velocity ($D > 1$) from free orbit around Sun at same speed as Earth.

In this note the circular orbit around the Earth was taken at 2,000 miles altitude giving x = 1.82 miles/sec. Variations in the altitude selected in the vicinity of the Earth have a relatively small effect on the results.

3. Velocity requirement for transfer from rest on the Earth's surface to elliptic orbit around Sun is:

$$V = \sqrt{(z^2 + y^2)}$$

where

z = velocity requirement to reach Earth escape velocity from rest on the Earth's surface

and y is as given in (2).

In this note, z is taken as 7.25 miles/sec. This figure is equal to the escape velocity near the Earth's surface, 6.9 miles/sec., with the addition of 0.35 miles/sec. to allow for the influence of the Earth's gravity and atmospheric drag. Actual figures are not likely to differ appreciably from this.

The Pioneer of Strawberry Vale

FROM 1959's complex, mixed-up aviation world, with its apprehensions and recriminations, I recently stepped back almost half a century, into the world of Gustavus Green. At Strawberry Vale, down Teddington way, in a big old house which is literally a back-water, for its garden runs down to the Thames, the 93-year-old engineer has lived quietly for nearly 40 years of retirement, spending a few hours each day in his work-room on the top floor, usually making or repairing lovely old clocks and watches.

Now somebody has discovered that he is *the* Green of Green Engines and the Press, TV and Radio have all come to do homage and to envy. In these raw winter days, he doesn't climb to his work-room and his hospitable son and daughter showed me into a big, cosily dark back room, where the coal fire's light gleamed on mellow furniture and pictures, mirrors and clocks, and only the TV set, on the great mahogany table, was vile.

Here Mr. Green, tall, active and happy, passes the winter days in a plaid dressing-gown and, completely in character, smokes a pungent shag tobacco. Over tea and biscuits and an open album of photographs, some of them sepia, we talked of a past age, when a man could teach himself engineering well enough to build cars almost single-handed.

Gustavus Green left his native Hounslow to start in Bexhill as, of all things, a ladies' hairdresser, but turned to cycle making and repairing, then made cars for customers such as Lord Francis Hope. On exhibition this particular car and its engine caught the eye of Col. Capper of the Royal Aircraft Factory (now the R.A.E.) and he ordered an 80 h.p. version for the "Nulli Secundus" airship then under construction.

Mr. Green's engine, with each of its six copper-jacketed cylinders separately cooled, produced 100 h.p. when delivered, and it was fitted instead into the Dirigible IIA of 1910. Col. Capper was so pleased he asked to have the first model of each subsequent Green design. So began the line of Green aero-engines which backed up the courage and capability of the British air pioneers.

On the advice of Wilbur Wright, Green produced a 35 h.p. vertical 4-cylinder engine. This powered Robert Blackburn's monoplane, A. V. Roe's Mercury triplane, Lieut. Schwann's Avro Type D biplane (the first successful seaplane) and emerged successful after World War I to power Bert Hinkler's Avro Baby to win the Aerial Derby Races of 1919 and 1920.

The 60 h.p. Green powered the Brabazon Short No. 2 biplane which won the *Daily Mail* prize for the first mile circuit by a British pilot in an all-British aeroplane. The 100 h.p. engine used by Colonel Cody and then by Grahame-White in his Aerobus can be seen at the Science Museum. In 1913 Mr. Green's 100 h.p. engine was in the Sopwith Batboat, Britain's first successful amphibian, which won the Mortimer Singer prize. In the same year Harry Hawker's Green-engined Sopwith seaplane flew over 1,000 miles in the *Daily Mail* Round-Britain Seaplane Race before crashing near Dublin when the pilot's foot slipped off the rudder-bar.

The prototype engines were made at Twickenham by Mr. Green, then the Aster Engineering Company of Wembley under the direction of Mr. Cook made the production model. Green Motor Patents Syndicate, Ltd., became the Green Engine Company, with Fred May looking after the commercial end.

Gustavus Green, the aero-engine pioneer, was made an Honorary Companion of the Royal Aeronautical Society on January 15 for his work on the design and development of the early Green engines.

The 6-cylinder 150 h.p. and 12-cylinder "Vee" of 300 h.p. followed the successful 100 h.p., and these engines were used in a few wartime aircraft but the Green Engine Company was ordered to concentrate on engines for M.T.B.s and other fast naval craft. By the end of that war, a 1,000 h.p. marine engine was being built.

Mr. Green drew my attention to a caption under a picture of one of these fleet M.T.B.s—"Speed 40 knots"—and commented, "They're not doing much better than that today."

In 1920, aged 55, Gustavus Green, on doctor's orders, retired from commercial life.

There are at least nine Green engines still in existence—four in the Science Museum; one at Farnborough; Fred May has a 35 h.p. which used to power one of his racing boats; Edinburgh Museum has a 100 h.p. engine; Mr. Green has a 60 h.p., beautifully restored by his engineer son; and, by happy chance, Mr. Cook of the old Aster company and his daughter, Mrs. Goodwin, an engineer, learnt of a 1908 35 h.p. model in the basement of the old Teddington house, and have undertaken its restoration.—WREN.

Some aircraft that were powered by Green engines:—

1909: Short No. 2 biplane (60 h.p.), Blackburn monoplane (35 h.p.). 1910: Avro Triplane Mercury (35 h.p.), Cody biplane (60 h.p.), Handley Page monoplane (35 h.p.). 1911: Avro Triplane (35 h.p.), Avro Type D biplane (35 h.p.), Flanders monoplane (35 h.p.), Valkyrie monoplane Type A (35 h.p.), Valkyrie monoplane Type C (60 h.p.). 1912: Avro enclosed biplane Type 502 (60 h.p.), Grahame-White Boxkite (60 h.p.), Sonoba biplane (60 h.p.), Pointer monoplane, Dunne birlane, Dunne monoplane, George and Jobling biplane. 1913: Cody biplane (100 h.p.), Gnospellius-Trotter biplane (100 h.p.), Sopwith Batboat (100 h.p.), Sopwith round-Britain seaplane (100 h.p.). 1914: Grahame-White Caravan (100 h.p.), Well Reo biplane (35 h.p.). 1915: Avro Pike 523A (2 x 150 h.p.), F.E. 2a (100 h.p.). 1916: Porte Baby flying-boat (central engine on some) (100 h.p.). 1919: Avro 504 (100 h.p.), Avro Baby Type 534 (35 h.p.). Airships: Dirigible IIA, Beta, Gamma.

Tupolev's Badger

ALTHOUGH specific performance and equipment details of the Tupolev Tu-16 (NATO "Badger") are necessarily largely speculative, it can be stated with complete confidence that THE AEROPLANE drawing opposite is the most accurate ever published of this Soviet medium bomber. Despite the universal security clamp on Soviet military aircraft, reasonable approximations of its leading particulars may also be gained from the close relationship of the Badger to its civil development, the Tu-104.

As one of several large jet aircraft designs emerging from the fertile collective of the veteran A. N. Tupolev, the Tu-16 owes much of its conception to the less-publicized second-in-command of that team, A. A. Archangelskii.

The Tu-16 made its first public appearance in a fly-past over Moscow in May, 1954, since when it has been produced in considerable numbers for service with the Dalnaya Aviatsiya—Russia's Strategic Air Command. It is now the most widely used type in that Command, and about 700-800 are believed to be in operational service.

When the Tu-104 appeared, a year or two after the Badger, it proved to have a common wing, undercarriage, powerplant and tail design, with detailed differences, and a new passenger fuselage. The Tu-104 also had its wing moved from the mid to the low position, which influenced the engine intake design. In the transport aeroplane the intakes are perfectly circular, with straight-cut profiles, and stand well clear of the fuselage. Being mounted higher up and closer to the slimmer fuselage the intakes of the Tu-16 are more complex in design, presumably to avoid airflow interference.

Coupled with the need for boundary-layer separation, this is undoubtedly the reason for the large channels in the fuselage, forward of the intakes, which are also slightly splayed outward and have flattened tops. As in the Tu-104, the Tu-16 uses two of the very large Mikulin-Zubets AM-3 turbojets, with an increased rating of about 20,000-lb. thrust each, necessitating generous intake areas.

With a gross weight of about 175,000 lb., the Tu-16 is therefore the largest twin-engined aircraft yet flown. Its thrust loading, however, is little more than those of our four-engined V-bombers, which are in an approximately similar weight bracket. With a rather higher wing loading the Tu-16 is likely to have a much inferior altitude performance, with a normal operating ceiling of about 35,000 ft.

Airframe design of this Russian bomber is conventional enough, and of substantially subsonic nature, with a 12½% mean t/c wing swept at 35°. A slightly curious feature is the omission of airbrakes from the design, as in the case of the Tu-104, but the rearward-retracting bogie-type undercarriage (into trailing-edge fairings) probably has a high limit speed for extension, to assist in rapid descents and deceleration. Another anomaly, by Western standards, is the lack of power controls in the Tu-16, which has heavy stick forces, particularly at high speeds.

The accommodation of the navigator in the large plastic nose compartment of the Tu-16, with its long optically flat bomb-aiming panel, lays a curious emphasis on visual navigation and bombing techniques, in contrast with the radar systems employed in the West. The nose sections of British and American bombers are almost entirely occupied by massive radar scanners, but the equivalent radome of the Tu-16 is a relatively small affair under the cockpit. Western navigators and radar operators practice their abstruse crafts in blacked-out compartments in the fuselage offering no view of the ground, except through an emergency bomb-aiming panel.

Yet another difference concerns armament. Defensive weapons have been completely abandoned in British bombers, and American types have only tail guns. The pre-collision course and missile attack conception of the Tu-16, however, is revealed by its extensive turret armament, with a corresponding penalty in weight, drag and crew requirements. Developed from the General Electric barbette system in B-29s confiscated by the Russians in 1945, the Tu-16 armament comprises a twin-gun turret above and below the fuselage, and a power-operated tail mounting.

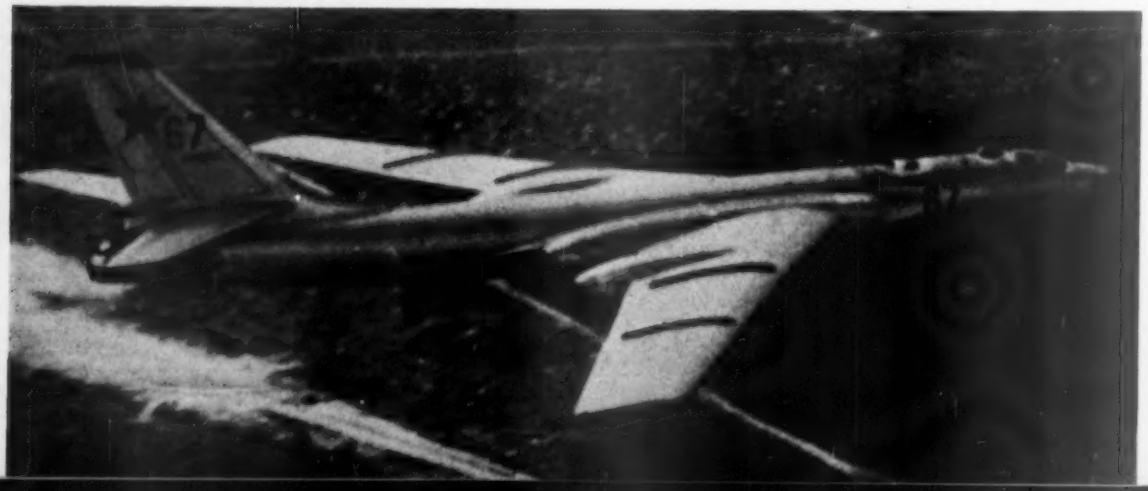
The turrets are of low profile design, the upper one being sunk in a large recess in the front fuselage, behind its sighting blister-cum-astro dome. The lower rear turret is controlled from either of two large blisters on the extreme aft fuselage, which terminates in the radar-controlled twin tail guns. There is an additional fixed cannon on the starboard side of the plastic nose, and all seven guns of the Tu-16 are believed to be of 23-mm. Nudelmann-Rikter pattern, as used in the MiG fighters.

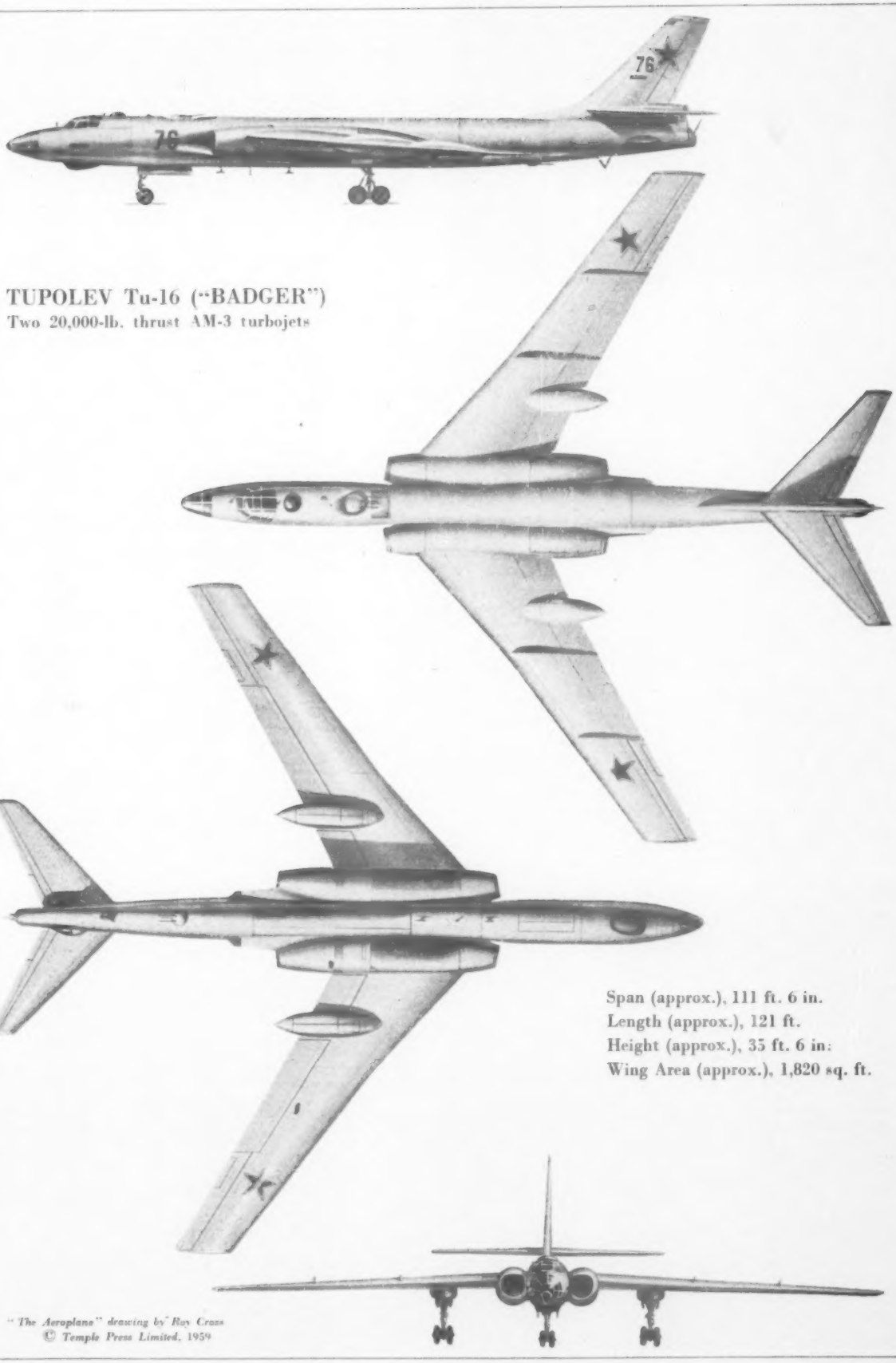
To man this armament the Tu-16 requires a rather larger crew than the five men carried by the British V-bombers, and at least seven members would appear necessary. They are accommodated in two pressurized compartments in the nose and tail, with no access in between during flight. The centre section of the fuselage is completely filled with fuel tanks and the bomb bay, the latter having a maximum capacity of explosive or nuclear weapons in the region of 20,000 lb. With some 7,000 gal. in the wing tanks, the total fuel tankage is something like 10,000 gal., resulting in an operating range of about 3,500 miles.

This may be extended almost indefinitely by flight refuelling, for which the Tu-16 has been adapted, using the British system of hose and reel. The Tu-16 is known to have acted both as tanker and receiver.

Normal limiting speed of the Badger would appear to be about M=0.87 (587 m.p.h. at 35,000 ft.) and on the basis of the rather fatter Tu-104, the cruising performance is between 480 and 540 m.p.h. Approach speed is in the region of 150 knots (172 m.p.h.), and the Tu-16 has provision for one or more tail braking parachutes.

This profile of the Tu-16, with its accent on visual bombing, and defence against cannon-armed interceptors, suggests an aircraft tailored primarily for a limited war. But this impression results from what little we have been allowed to see published, and the Tu-16 is undoubtedly capable of fulfilling the full strategic nuclear rôle on which Western deterrent policy depends. Although its effect, in this task, may be achieved mainly by quantity, rather than quality, it is still a potent backing to the Soviet ballistic-missile threat.





TUPOLEV Tu-16 ("BADGER")

Two 20,000-lb. thrust AM-3 turbojets

Span (approx.), 111 ft. 6 in.
Length (approx.), 121 ft.
Height (approx.), 35 ft. 6 in.
Wing Area (approx.), 1,820 sq. ft.

"The Aeroplane" drawing by Roy Cross
© *Temple Press Limited*, 1959

Left, Air Vice-Marshal G. Silyn-Roberts addresses the apprentices at Hunting Aircraft on January 14. The prize-winners included (left to right) M. R. Turner, best technical apprentice; Miss Penelope Dudley, Lawes Rabjohns Prize; G. E. Bray, best practical apprentice; and M. J. Webb, best all-round apprentice.

Prize-giving at Luton

AIR VICE-MARSHAL G. SILYN-ROBERTS, C.B.E., A.F.C., M.Sc., F.R.Ae.S., Director-General of Engineering at the Air Ministry, was the guest speaker at the annual presentation of prizes and awards to apprentices of Hunting Aircraft on January 14. In an entertaining speech which contained much good advice, he suggested to the apprentices that no matter how extensive their knowledge, its value would be considerably reduced if they were unable to convey it to others. He stressed the value of team work in all aspects of engineering, and cited as an example the development of pilotless aircraft. In this, he said, there was much that could not have been achieved if electrical, radio, mechanical and aeronautical engineers had not been prepared to exchange ideas freely.

The Air Vice-Marshal also had something to say about the need for reliability and commented upon the high cost to this country of unreliability of equipment in the R.A.F. A major cause of unreliability was, he thought, man's inability to make a multiplicity of parts identical; but this was something that would have to be put right somehow or other.

In his annual report MR. H. G. HAMMOND, the company's superintendent of training and studies, said that during the year they had continued to accept overseas students under the international exchange scheme.

The company now had 10 undergraduate apprentices on degree or diploma courses at Southampton University, Northampton College of Advanced Technology, Loughborough College of Technology, Hatfield Technical College and Luton College of Technology. This, said Mr. Hammond, represented about 10% of the company's total education effort.

MRS. C. P. M. HUNTING presented the prizes and awards; M. R. TURNER, chairman of the Apprentices Association, proposed a vote of thanks.

A Pioneer Specialist

WITH the death of Louis Arthur Rumbold on January 9 at his home in Ealing, five days short of his 63rd birthday, the firm of L. A. Rumbold and Co., Ltd., lost its chairman and managing director, and British aviation a well known and widely liked personality. Tough, forthright and never afraid to say what he thought, Louis Rumbold had been conspicuous on the British aeronautical scene for 30 years.

In THE AEROPLANE for September 21, 1932, an announcement appeared that Mr. L. A. Rumbold and Mr. Boyd-Carpenter had bought all the plant, machinery, stock and manufacturing processes of Boyd-Carpenter and Co., Ltd. The business was to be carried on at the same address: Kingsgate Place, Kilburn, London, N.W.6, but the name of the business was to be changed to L. A. Rumbold and Co.

The company, it was then reported, were doing a great deal of aircraft work and were able to supply everything for the interior furnishing of aeroplanes, large and small. It specialized in the production of lightweight chairs, making use of Elektron. Imperial Airways' new A.W. Atalanta monoplane, was equipped with Rumbold chairs.

Louis Rumbold's interest in upholstery for aircraft, and more particularly in seating for aeroplanes, had begun while he was still with Mr. Eric Gordon England, who in the 'twenties was well known not only for his aeronautical pioneering but his production of lightweight car bodies. In consequence, inquiries were also received for lightweight aircraft seats and the like. Before joining Mr. England, Louis Rumbold had served with the R.F.C.

After he had set up on his own, Rumbold chairs became widely known and used. By the time the Second World War had started, his work for British civil aeroplanes, in particular those used by Imperial Airways, had given him international status.

This experience was turned to military use during the Second World War when L. A. Rumbold and Co. were strenuously engaged on the fabrication of seating for aircrew.

Large and heavily built, Louis Rumbold used to reckon that a fine test of a chair was to ride in it himself for an air trip of suitable length. But quite apart from flying widely on air routes on the business of his company, he used to make a point himself of flying in aeroplanes in their most primitive condition to decide necessary steps for effective soundproofing.

Since the War, the business he founded and led has contributed to the comfort of passengers by air in many places. It will be not surprising, when the record is examined, if Louis Arthur Rumbold, Associate Member of the Institute of British Engineers, Fellow of the Royal Society of Arts, is found to be the pioneer specialist in aircraft seating.—T.J.

An Early Air Correspondent

LT.-COL. HARRY DELACOMBE, O.B.E., who died at the advanced age of 86 at Brighton on January 10, was one of the very small band of original air correspondents or specialist writers on air matters. If he had been in better health his friends would have wished for him to have been spared to see the jubilee celebration of Blériot's crossing of the Channel scheduled for July next. In his rôle as correspondent for *The Times* Harry Delacombe was at Calais, in July, 1909.

Born on February 7, 1872, the young Delacombe was educated at the R.N. School and on H.M.S. "Britannia." He resigned from the Navy at the age of 20 because, he told a friend, he had recently been married. From 1907 until 1910 he was aeronautical correspondent of *The Times*.

We have the authority of Mr. Geoffrey Dorman for an account of how this came about. It seems that after resigning he was posted to the Admiralty as a civilian to write reports on current affairs in the Navy and Army of the United Kingdom and foreign countries. In that capacity he came into contact with Col. J. S. Templer one of the fathers of British aeronautics who in 1907 was instrumental in the construction of the first British Army airship, the "Nulli Secundus," which flew from Farnborough to London, circling the dome of St. Paul's in October, 1907. Templer was so impressed with the report Harry wrote on this event that he took him to the office of *The Times*, who engaged him to write a weekly article.

He was a founder member of the Aero Club in 1908 and a staunch supporter of its activities. He was, for instance, Press steward at the Blackpool Flying Meeting in 1909. For the meeting there the following year he was organizer and clerk of the course. The same year, 1910, he became manager of the Beaulieu Flying School. Next year he was adviser to the Bristol Company. From 1912 until 1914 he was aeronautical adviser to Armstrong Whitworth. On the outbreak of the Kaiser's War he joined the Royal Naval Air Service. From 1915 until 1918 he was commandant of the Naval and Military Kite Balloon headquarters.

Geoffrey Dorman recalls meeting him for the first time at Roehampton where kite balloon observers were trained and where at that time Delacombe was in command. On the formation of the R.A.F. in 1918 he became assistant director of air organization at the Air Ministry until 1919.

Delacombe then took an active part in various sporting flying meetings. In 1937 he became a director of Jablo Propellers, Ltd., in 1945 he became chairman, a position from which he resigned shortly before his death. From 1939 until 1945 he was chairman of the Air League.

He was a Chevalier of the Legion of Honour.

Many of his friends in later life must have cut their teeth on his "Boys' Book of Airships," which appeared in 1910.

His tall, elegant figure and charming manner made him conspicuous. When his last illness finally wrested him from his favourite fire-place at the Royal Aero Club, 119 Piccadilly lost something characteristic. All who were privileged to count him as a friend will long remember him.

All turboprop-powered aircraft
in Fleet operation
with Rotol propellers

HARVEY

G. A. HARVEY & CO. (LONDON) LTD. were responsible for the constructional design and fabrication of the Pressure Ducting, Contraction Cone and Diffuser of the A.R.A. Supersonic Wind Tunnel at Bedford. The illustrations show the Contraction Cone before installation (top) and the Diffuser Section on site (left).

Harveys were also responsible for the fabrication of the Contraction Cone, Working Section Shell, Air Entry and Removable Section, Fan Casing and Stator Vanes, and the Ductwork (auxiliary suction plant) of the A.R.A. Transonic Wind Tunnel which has been in operation since 1956.

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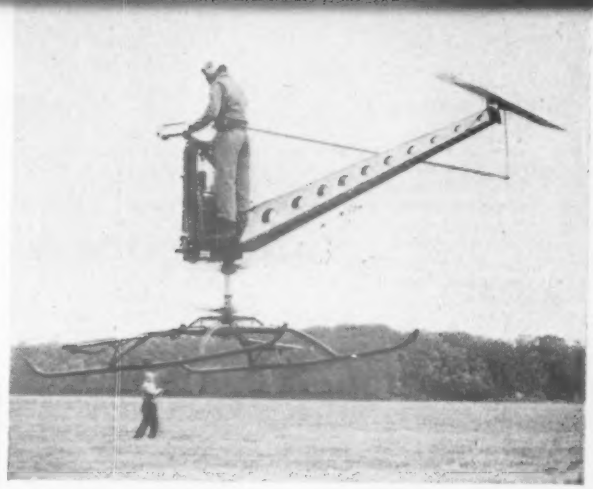
New World Photo-News

Pictures from Howard Levy



Above and left, new variations of the deLackner Aerocycle are seen in these pictures. The type is being tested at Forrestal Research Center.

Right, used by a commercial organization in Indiana as an executive aircraft is this D.H. Vampire 3, ex-R.C.A.F., one of a batch purchased from the Canadian Government.

Left, Service load-carrying capabilities of the Vertol YHC-1 being demonstrated by the transport of a mock-up of an Honest John missile and its warhead.

Below, being evaluated by the U.S. Army at Fort Rucker is this S.O.1221S Djinn, which has received the designation YHO-1DJ. It has a gross weight of 1,675 lb., a useful load of 881 lb. The operational range is 97 nautical miles.

Below, this Martin B-57A Canberra is used by the Federal Aviation Agency (formerly the C.A.A.) for high-level flight inspection and experience flying. The fuselage and rudder markings are in "Day-Glo."

Private Flying

H.J.C.'s CLUB COMMENTARY

● IN Northern Ireland the Druine Turbulent, G-APCM, built by Father O'Kelly of St. Mary's Training College, at Belfast, has now flown about 5 hr. on test preparatory to getting its Permit to Fly.

The first flight was made by Jock Eassie, one of Short's test pilots, at Ards. This aircraft has an Ardem engine supplied by Rollasons of Croydon.

● IT can now be confirmed that the 1959 National Air Races and the British Lockheed international aerobatic trophy will be held at Baginton, Coventry, on July 9-11.

Other notable dates in this year's sporting calendar are the R.Ae.C.'s La Baule rally (June 27-29), and the Deauville rally (July 4-6).

● A LIST published by the Fédération Aéronautique Internationale also gives the following events:—

April 24, fourth Tangier rally, Morocco; May 23-25, Quiberon Air Club rally; May 24-31, Milan Aero Club rally; May 30-31, sixth Dauphine Aéro-Club rally, Grenoble; May 30-June 1, Moselle and Luxembourg wines rally; June 6-7, Florence Aero Club rally; June 13-14, 11th Lower Normandie rally at Flers; June 17-20, Parachuting contests organized by the Fliegergrupper Leutkirch at Leutkirch Unterzeil, Germany; June 19-22, Royal Dutch Aero Club rally at Rotterdam; June 26-29, air tour of Sicily; June 27-28, Aix les Bains rally of the Savoie Aéro-Club, France; and June 30-July 5, Italian Aero Club's air week at Rome and Venice.

Other events noted are:—

July 4-5, Anjou air rally; July 11-12, Pescara air rally; July 18-19, air rally at Verona, Italy; July 25-26, 50th anniversary celebrations of Louis Blériot's Channel crossing, in France; September 11-13, Baden Baden air rally organized by the Deutscher Aero Club; and September 26-27, rally organized by the Genes Aero Club, Italy.

● LAST SUMMER the first flight of a new five-seat all-metal touring aircraft —the DA-1 built by the Davis Aircraft Corpn.—was made in the U.S.A. and the prototype has now flown about 70 hr. on test.

Simplicity of design is a feature of this aircraft, which has a 180-h.p. Lycoming O-360-A1A engine. The high wing has external ribs each formed from T-section extruded aluminium, and the absence of internal structure simplifies assembly and repair. An all-flying V-tail has been used to reduce drag, weight and components. Each surface contains 13 structural pieces (there are only 40 in each wing) and right and left units are interchangeable.

The wide-track main undercarriage is of the tubular steel spring type and the nose-wheel has direct steering.

Span, 31 ft.; length, 22 ft. 5 in.; wing area, 163 sq. ft.; empty weight, 1,200 lb.; loaded weight, 2,370 lb.

The DA-1 cruises at 125 m.p.h.; it is expected to sell for less than $10,000.

Hideaki Levy photograph

The prototype Davis DA-1 five-seater referred to on this page.

Gliding Notes

by Dr. A. E. Slater

BRISTOL GLIDING CLUB suspected that their Nympsfield site was in the downwash of a standing wave on the morning of January 4 because, in spite of a 15-knot N.W. wind blowing up the hill, the lift was only patchy and very rough. Two people trying for 5 hr. came down after 30 min., and after that nobody could stay up.

Fortunately the club now has a Tiger Moth, so it was put to work in the afternoon. Sure enough, Alfred Samuels released at 2,000 ft. over the valley into dead smooth air going up just as fast as the club Olympia sank through it. A little later, Douglas Jones took the club Skylark into improved lift and reached 5,000 ft., while Alan Newton reached 4,000 ft. in the Olympia.

All this time there was still no lift over the windward face of the hill at Nympsfield, although Samuels found a wind of 37 or 38 knots blowing in the wave lift. Such a speed is rather surprising, as the general gradient wind, according to the spacing of isobars on the weather chart, should have been only 18 knots. In theory this localized acceleration should have caused a big enough drop in pressure to give a measurably false altimeter reading, if only the meteorologists who believe this had been there to measure the true height of the sailplanes. Yet an aerodynamicist assures me that you don't experience this reduction of pressures if you are immersed in the air stream.

The position of the wave lift was mostly between the River Severn and the A38 Bristol-Gloucester main road: that is, three to seven miles upwind from the club, and three to seven miles downwind from the leeward edge of the Forest of Dean, the nearest high ground to windward. So it must have been the first upward rebound, and Nympsfield got the first downward rebound, with a wave length of 10 miles or a bit less.

* * *

RECENT adventures of some of Slingsby's products in far-away countries are described in the firm's latest newsletter. Waves in New Zealand, though normally as smooth-flowing as waves elsewhere, can produce some of the World's worst patches of turbulence. Dr. P. K. Renshaw has done many high flights in waves over North Island in his T-42 Eagle, but while being towed off on one occasion the turbulence was so fierce that the nylon tow-rope looped back behind the Eagle's wing, so he had to cast off at 500 ft. and put down in the only available landing spot—a small sandy beach.

Another Eagle operates in South Island, and last September S. H. "Dick" Georgeson, one of its owners, once again beat his own national height record by reaching 32,500 ft. a.s.l. in a lee wave from the Southern Alps. His gain of height was only 400 ft. short of the World's record set up by W. B. Ivans at Bishop, since the New Zealand wave can be contacted from a launch to a few hundred feet, whereas at Bishop a preliminary tow to about 10,000 ft. is necessary.

All types currently being built can be obtained in kit form for roughly 60% of the finished price, and at present a Skylark 3 is being built from kit by Charles Ross and other members of the Scottish Gliding Union, while a Skylark 2 fuselage and tail are being put together at Bicester by Chris Hurst and a companion, who will buy the wings complete. As an example of how a Swallow can be built cheaply from kit, for which it was specially designed, Slingsby suggests four people putting £50 each into the fund to start with, and thereafter each contributes £1 a week for 18 months.

* * *

UPPER air figures for the Midland Club's best wave day, December 27, during the "wave safari" camp, have now arrived and show two stable layers: an inversion of 2°C., about 600 ft. thick, at roughly 9,000 ft., and an isothermal layer of similar thickness at about 14,000 ft. The two best heights mentioned in the last Notes were measured from release, and actually John Anstie reached 11,200 ft. above sea level, and David Hooper and Ann Newton 9,700 ft. in their Eagle. Unfortunately Anstie's barograph wasn't working, so it registered no Gold "C" height.

Winds reported at 11.00 hrs. on that day increased with height up to 42 knots at 3,000 ft., then dropped to 40 knots at 5,000 ft., and thereafter increased rapidly again with height up to a jet-stream velocity of 123 knots at 34,000 ft.

On January 4, the day of the Bristol Club's wave, Brenda Horsfield made the best climb of the day at Long Mynd—6,200 ft.

Visitors to the camp from Lasham numbered 34, and, writes Ted Stark, about half of them had never soared over a slope before. Of the 10 visiting machines, four club-owned ones put up 42 hr. 55 min. and six private ones 18 hr. during the camp, all from 91 launches.

During 1958, John Hinkling writes, 2,550 hours' flying was done from 6,500 launches at the Long Mynd; this is a record, and so is the present number of members, 270. A second T-21b will be ready for the instruction courses; its fuselage is being built by Teddy Proll in the workshop. Another forthcoming acquisition is a German Pfeiffer retrieving winch, to save the Mynd from being further churned up and worn down; also, it is hoped, to double the launching rate.

The club is holding its usual rally at Easter and welcomes competitors, who will be marked on the same system as last year. The period is March 27-31.

COLD SPOT.—Members of the Midland Gliding Club rigging a Slingsby Skylark at the Long Mynd on January 4.

Correspondence

On the Hour Every Hour

IN the early days of airline flying at Croydon the late C. G. Grey often advocated that before civil aviation could really fully serve the public need people should be able to go to Croydon and catch an aeroplane for Paris, every hour on the hour.

Air France announce that next summer there will be a service from London to Paris every two hours on the hour from 08.00 to 22.00 hrs. So if B.E.A. operate a similar frequency on the hour between, we shall achieve C.G.G.'s dream.

The next thing should be not to have to make advance booking and if you arrive at the airport 15 minutes before time of take-off to be able to take your ticket and go aboard. That'll be the day!

London, S.W.5. GEOFFREY DORMAN.

No. 87 Squadron—History

A COMPREHENSIVE history of No. 87 Squadron is being compiled. Any contributions in the form of photographs, articles, documents, etc., from ex-members would be greatly appreciated. These will be returned when copies have been made.

All correspondence should be sent to me, No. 87 Squadron, R.A.F., Bruggen, B.F.P.O. 40, Germany.

B.F.P.O. 40. SQN. LDR. W. R. COLLINS.

A Single-engined Ju 52 in Canada

I NOTE with interest the letter from Mr. Walter Zuerl in your issue of January 9, confirming the fact that the Junkers Ju 52, started life as a single-engined aircraft. I personally have had many arguments with otherwise knowledgeable people over the existence of such an aircraft and, generally, the attitude taken was one of disbelief or, at best, that I was mistaking earlier single-engined models such as the Ju 32 (or was it Ju 34?).

You may be interested to know that Canadian Airways, or Western Canada Airways as it was called at that time, bought and operated a single-engined Ju 52 in 1931. It was used in the north country for a number of years and gave excellent service both on floats and on skis. If I remember correctly this particular aircraft was powered with a B.M.W. engine when it arrived in Winnipeg on delivery but later I think this was changed for a Rolls-Royce engine, either a Buzzard or a Goshawk, I can't remember which. The propeller was, in effect, a four-bladed affair made up of two enormous single-bladed airscrews mounted at right-angles to one another on a common shaft.

I remember the aircraft arriving in Winnipeg very clearly as it was greatly publicized, and several aircraft from Stevenson Field escorted the giant on the last few miles of its journey. I piloted one of these, a D.H.60X Moth, and felt completely dwarfed flying alongside the monster which arrived on December 28, 1931, piloted by Alex Schneider who was either a Lufthansa or Junkers pilot. The registration letters were, I think, CF-ARM, but anyone interested in following up the career of this aircraft could probably obtain a lot of information from *Canadian Aviation*.

One further point of interest—the aircraft's floats were double-chined and long enough for two of them, side by side, to take up a whole C.P.R. flatcar!

Hartley Wintney, Hants. J. A. KENT.

Polar Pioneers

WITH reference to the article on the above subject in your issue of January 2, 1959, the engine in question was an R.E.P. 5-cylinder fan-shaped engine, air-cooled.

The aircraft was bought from R.E.P. France and assembled at Erith and the constructional rights were obtained by Vickers Sons and Maxim, Ltd. From this arrangement the first Vickers aircraft were designed under the guidance of A. R. Low and Rex Pierson.

The engine was also developed into a nine-cylinder air-cooled radial engine of 100 h.p., but development was subsequently stopped.

Cricklewood, London, N.W.2. J. MCKENNA.

Groundabout

Per Ardua ad Belfast. How's your Irish brogue? Remember it while you read this story of an Air Ministry party, who, to visit Short's at Belfast, travelled across on the night boat. At the bleak dock-side they found a Short coach but no driver. They waited patiently, then impatiently, and their Wing Commander leader returned to the gangway to seek the driver. He met him coming to the coach and looking puzzled. "Sorr," he said, "did ye see a party of monks come off the boat? I had to take them to Short's." "No," said the Wingco, "but that's where my party's going." "Tell me," said the driver, "are ye from the Air Monastery?"

*

Let-down. Talking of Short's, I must say I think their chief engineer, Hugh Conway, missed the quote of 1958 when Tom Brooke-Smith landed the S.C.1 on a Belfast football pitch. Mr. Conway contented himself with "A tremendously significant achievement." Surely, the only really valid comment was (hat raised, head erect): "Gentlemen, we have reached our goal."

*

Beamont in Orbit? English Electric tell us that "the Lightning has been flying at twice the speed of sound for more than four months."

*

Let's Face It Dept.

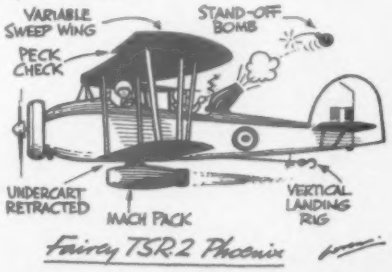
Wanted—Stewardesses . . . *ability to swim.—From Advt. in "Daily Telegraph."*

*

Fast One. If the *Avro (Canada) Aircraft News-magazine* has reported him correctly, our old friend "Zura" Zurakowski, who has just switched from Chief Development Pilot to Staff Engineer, Technical Design, is now a genuwine North American. When asked "How do you feel, travelling in the Arrow at such terrific speeds?" Zura is said to have replied "It's this way—it's like driving slow. Only faster." Incidentally, taking over the Arrow flying is "Spud" Potocki, ex-E.T.P.S. and R.A.E. pilot. Remember the time he hacked a hole in, I think, a Valetta, to reach out and free a parachute from the tail-plane? One other piece of Polish news—Zura's brother is a designer of the new Polish ZUK helicopter.

*

Fairey Phoenix. Kenneth Hunter, an Air Gunner on 836 Sqn.'s Swordfish operating from the first and subsequent MACships in the War, very loyally claims that the old T.S.R. (Torpedo Spotter Recce.) Stringbag would fulfil most of the new T.S.R. (Tactical Support and Strike Recce.) specification requirements, especially the vertical take-off and landing part. For supersonic performance, partially fold the wings and fit a jet pod in the torpedo rack in place of the former bicycle and squadron stores. To help Fairey's projects staff, here's a sketch based on one sent by Mr. Hunter.



*

Initial Reactions. Following this magazine's recent light-hearted article which recorded some unofficial definitions of airlines' initials, a couple of bitter definitions have come in from private flying enthusiasts. One that I find difficulty in going along with is "Abode of Ruddy Bull" for A.R.B. The other deals with M.T.C.A. which, not unreasonably, ends up as "Ministry for the Termination of Croydon Airport."

by Lorenzo

NOTES AND EVENTS

ANGLO-AMERICAN.—The Napier Spraymat electrical surface de-icing system, manufactured under licence by the PacAero Engineering Corpn., of Santa Monica, Calif., is used on the spinners of the Lockheed Electra. This picture shows the metal-heating elements being sprayed on with a flame gun.

FOX STEELS.—A data sheet on Jethete M.151 Steel has been published by Samuel Fox and Co., Ltd., of Sheffield. A high-strength transformable stainless steel, Jethete M.151 is suitable for welding.

FURTHER EDUCATION.—At the Massachusetts Institute of Technology, the name of the Department of Aeronautical Engineering has been changed to Department of Aeronautics and Astronautics. It will continue to be headed by Dr. C. S. Draper.

MACHINE TOOLS. — The Elgar Machine Tool Co., Ltd., has formed the Gate Machinery Co., Ltd., to handle machine tools. This new company began operation on January 1 under the direction of Mr. J. P. Hatfield, who until recently was manager of the Machine Tool Division of Newman Industries, Ltd.

U.K. DIRECTION FINDING.—The M.o.S. has ordered a number of VHF direction finders from Marconi's Wireless Telegraph Co., for use at airfields in the U.K. Ordered on behalf of M.T.C.A., the new units will provide a total of 24 DF channels, including four at the Southern A.T.C.C. and dual channel installations for the Northern and Scottish A.T.C.C.s.

SAILPLANE BUILDING.—Published by the Technical Service Department of Ciba (A.R.L.), Ltd., of Duxford, "Technical Notes 192" describes the use of synthetic-resin adhesives in sailplane building. The article is based on a paper presented by the company at the seventh OSTIV Congress at Leszno, Poland, in June, 1958.

PRESSURE PICK-UPS.—The agreement signed in 1957 between the Consolidated Electrodynamic Corpn. of Pasadena, Calif., and the Solartron Electronic Group, Ltd., Thames Ditton, to manufacture and sell Datatape magnetic tape recorders for data processing has been extended to include a range of C.E.C. pressure pick-ups primarily developed for the aircraft industry.

S.T.C. ORDERS.—The M.o.S. has ordered a number of C.A.D.F. (commutated antennæ direction finding) and Triangulation automatic radio-navigation systems from Standard Telephones and Cables, Ltd., for use by the Services. The company has also received orders from B.O.A.C. and B.E.A. for its type SR23/33 airborne radio-navigation and landing-system receivers.

SURVEILLANCE RADAR. — Decca Radar, Ltd., has produced a new brochure on its long-range terminal surveillance radar type D.A.S.R.1. Largely technical, the publication deals with the equipment's operational performance, principle of operation, special techniques, installation and specifications. Principle details of the D.A.S.R.1. were described in THE AEROPLANE of June 13, 1958 (p. 808).

DEFROSTING AT L.A.P.—Simon 40-ft. hydraulically actuated towers mounted on Bedford trucks are used by B.E.A. for aircraft defrosting. The compound is a preheated mixture of Kilfrost DC 2 and water and two units can defrost a Viscount in less than 30 minutes.

Aviation Calendar

January 26.—R.Ae.S. Halton Branch lecture, "The Beverley in Service," by Gp. Capt. F. C. Griffiths, at the Branch H.Q., R.A.F., **Halton,** at 18.45 hrs.

January 26-29.—Institute of the Aeronautical Sciences, 27th Annual Meeting, at the Hotel Astor, **New York,** U.S.A.

January 27.—R.Ae.S. lecture, "Some Aspects of the Engine Noise Problem," by P. Lloyd, in the library, 4 Hamilton Place, **London,** W.1, at 19.00 hrs.

January 28.—R.Ae.S. Southampton Branch lecture, "Recent Developments in Noise Suppression," by Prof. E. J. Richards, in the Institute of Education, University of **Southampton,** at 20.00 hrs.

January 28.—R.Ae.S. Weybridge Branch, film show at the Apprentice Training School, Vickers-Armstrongs (Aircraft), Ltd., **Weybridge,** at 18.10 hrs.

January 29.—R.Ae.S. Bristol Branch lecture, "Guided Missiles—II," at Filton House, **Bristol,** at 18.00 hrs.

January 29.—R.Ae.S. Preston Branch lecture, "Flying Boats," by M. J. Brennan (Saunders-Roe), in the Hewitt Lecture Room, **Lytham,** at 19.30 hrs.

January 29.—R.Ae.S. Belfast Branch lecture, "Scientific Research with High Altitude Rockets," by Dr. E. B. Armstrong, in lecture hall LG8, David Keir Building, The Queen's University, **Belfast,** at 19.00 hrs.

February 2.—R.Ae.S. Derby Branch lecture, "Performance Problems in Large Rocket Engines," by S. L. Bragg, at the Rolls-Royce Welfare Hall, Nightingale Road, **Derby,** at 18.15 hrs.

February 2.—R.Ae.S. Henlow Branch, Presidential Address, by L. H. G. Sterne, in Building 62, R.A.F. Technical College, **Henlow,** at 19.30 hrs.

February 2.—R.Ae.S. Glasgow Branch, Graduates and Students Section lecture, "Tropical Trials of the Scottish Aviation Twin Pioneer," by J. Chalmers and Captain J. Blair, at the Scottish Aviation Technical School, **Prestwick,** at 19.30 hrs.

February 3.—R.Ae.S. Boscombe Down Branch lecture, "The Training of Soviet Engineers," by E. G. Sterland, in the lecture hall, A. and A.E.E., **Boscombe Down,** at 17.45 hrs.

February 3.—R.Ae.S. Luton Branch lecture, "Systems Simplified," by J. Wotton (Hunting Aircraft), in the Napier senior staff canteen, **Luton Airport,** at 18.15 hrs.

February 4.—R.Ae.S. Brough Branch lecture, "Production of the P.1," by T. O. Williams (English Electric), at the Royal Station Hotel, **Hull,** at 19.30 hrs.

February 4.—R.Ae.S. Christchurch Branch lecture, in conjunction with the British Association for the Advancement of Science, at the King's Arms Hotel, **Christchurch,** at 19.30 hrs.

February 4.—R.Ae.S. Gloucester and Cheltenham Branch lecture, "Supersonic Propulsion," by Dr. R. R. Jamison (Bristol Aero-Engines), at the Wheatstone Hall, Brunswick Road, **Gloucester,** at 19.30 hrs.

Company Notices

NEW COMPANIES

D. J. Allen (Aero-Motors), Ltd. (618,183).—Private co. Reg. Jan. 5. Cap. £100 in £1 shs. Objects: To carry on the business of mechanical and general engineers, etc. Directors: Dennis J. Allen, 36 Harwater Drive, Loughton; Leslie C. Parker, 80 Hurst Drive, Waltham Cross, directors of D. J. Allen Engineering, Ltd. Sec.: L. C. Parker. Reg. Off.: Barclays Bank Chambers, The Broadway, London, N.9.

P.M. Steels, Ltd. (617,954).—Private co. Reg. Jan. 1. Cap. £100 in £1 shs. Objects: To carry on the business of importers, exporters, merchants, traders in ferrous metals and their alloys applicable to the aircraft industry, etc. Directors: Philip Mullins, 14 Sellers Hall Close, London, N.3; Henry Brandes, 37 Woodside Avenue, London, N.6, directors of P.B.A. Metals, Ltd. Sec.: H. Brandes. Reg. Off.: 14 Sellers Hall Close, London, N.3.

New Patents

APPLICATIONS ACCEPTED

809,798.—Sebac-Nouvelle S.A.—"Injector for moving a fluid at high speed."—July 23, 1956. (July 29, 1955.)

809,823.—Babany, A.—"High-lift supersonic wing-section."—Jan. 24, 1955.

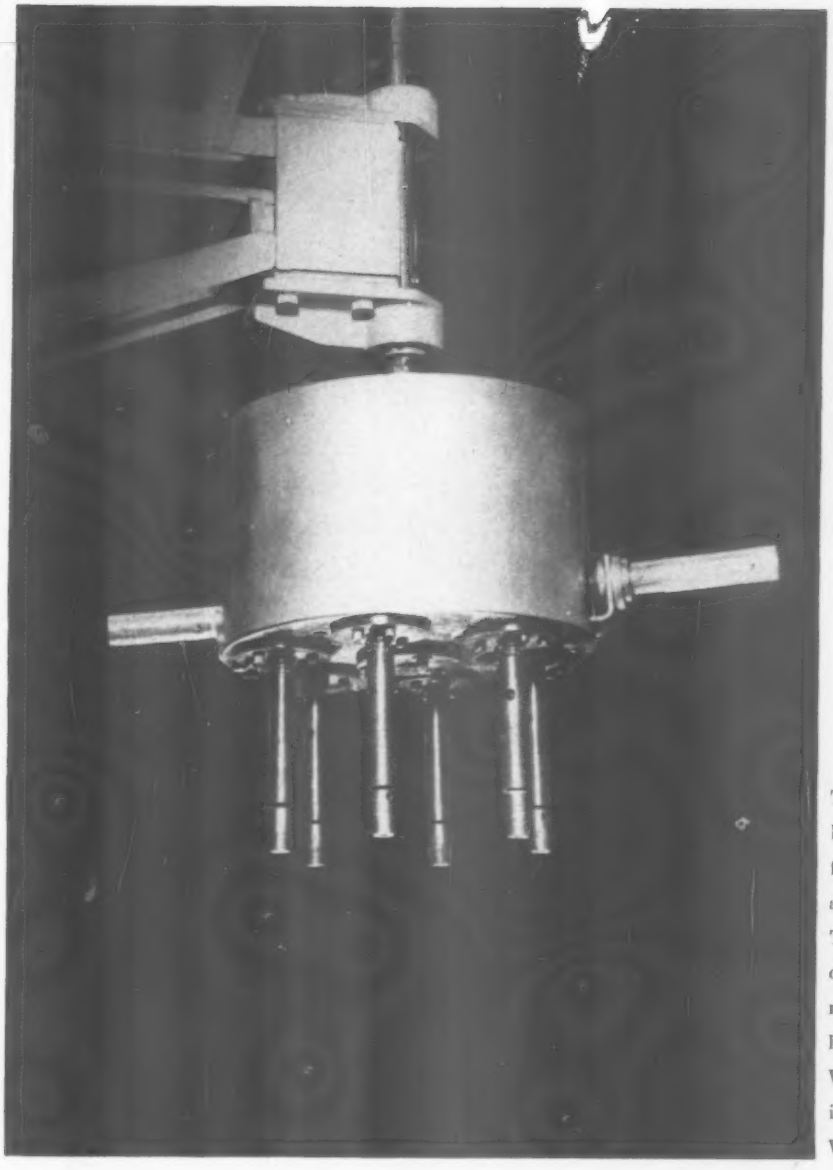
809,947.—Cooke, W. D.—"Helicopters."—Nov. 30, 1956. (March 27, 1956.)

809,948.—Cooke, W. D.—"Whirling-arm apparatus."—Nov. 30, 1956. (June 15, 1956.) (Divided out of 809,947.)

809,949.—British Messier, Ltd.—"Aircraft undercarriages."—April 3, 1957. (April 6, 1956.)

809,950.—British Messier, Ltd.—"Aircraft undercarriages."—April 15, 1957. (April 17, 1956.)

Applications open to inspection on March 4, 1959; opposition period expires on June 4, 1959.



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THERMODYNAMICIST to carry out detailed studies into the behaviour of liquid gas systems under various heat transfer conditions.

Qualifications required are a degree in physics or engineering with preferably some experience of similar problems.

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- The help of our staff to prepare and submit your application for an import licence.
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NOTICES

AIR TRANSPORT ADVISORY COUNCIL.

THE AIR TRANSPORT ADVISORY COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services:—

FROM THE BRITISH OVERSEAS AIRWAYS CORPORATION OF LONDON AIRPORT, HOUNSLOW, MIDDLESEX:—

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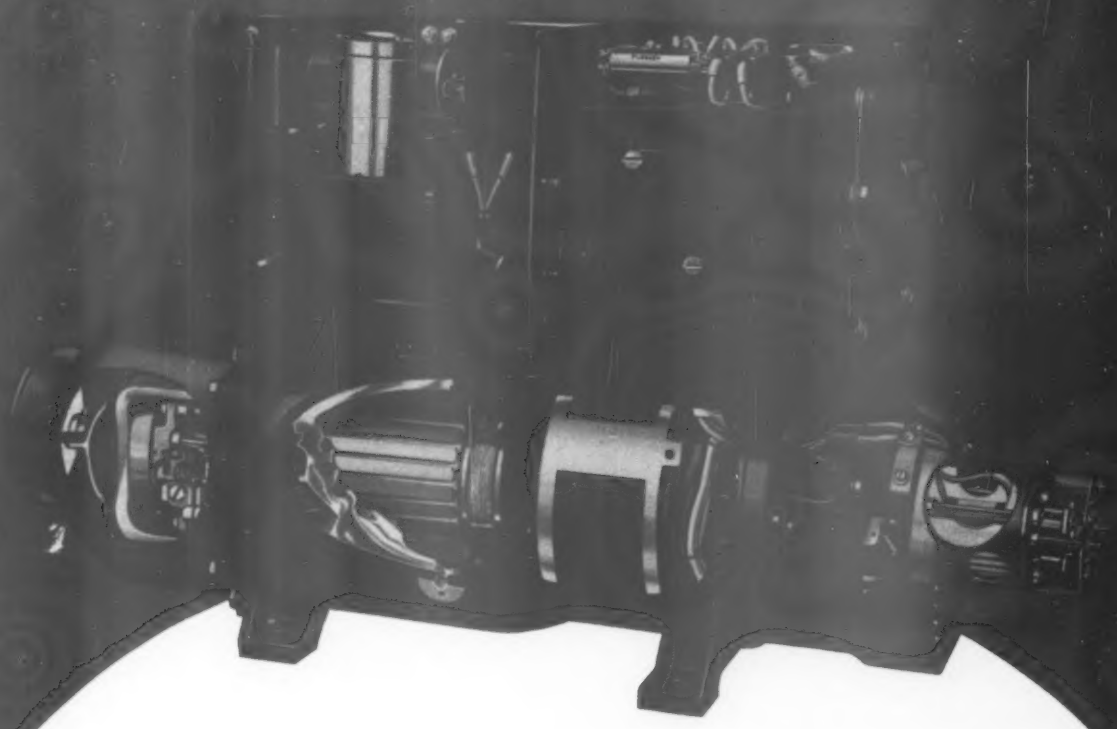

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